Development of the Worldwide harmonized Light vehicle Test Procedures (WLTP) in the framework of the World Forum on the Harmonization of Vehicle Regulation (WP 29)

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Outline

• Why a new test procedure?
• Objectives of WLTP
• Organization & Action
• Test Cycle and Procedure Development
  • NEDC – WLTP Comparison
  • Test of Electric and Hybrid Vehicles
• Further Steps and WLTP Implementation
Why a new test procedure?

- The test cycle defines conditions and vehicle speed sequences for the driving on the chassis dynamometer in order that is repeatable and reproducible.
- It should reproduce real driving conditions as close as possible.
- Meeting the emission limits at type-approval is crucial for the national vehicle homologation.

Bild: Rollenprüfstand TÜV Hessen; Quelle: www.tuev-hessen.de
Why a new test procedure?

The fuel consumption figures (CO₂) at type-approval are significantly lower than in real-life.

ICCT 2013: [http://www.greencarcongress.com/2013/05/icct-20130529.html](http://www.greencarcongress.com/2013/05/icct-20130529.html)
Why a new test procedure?
Type-approval vs. Real-life

Diesel, Nitrogen oxide (NOx) emissions (in g/km)

Euro 3
2000

Euro 4
2005

Euro 5
2009

Carslaw et al., 2011
WLTP Project

United Nations Economic and Social Council

ECE/TRANS/WP.29/GRPE/2013/13
Distr.: General
17 September 2013
Original: English

Global Registry

Created on 18 November 2004, pursuant to Article 6 of the Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles (ECE/TRANS/132 and Corr.1) done at Geneva on 25 June 1998

Addendum 15: Global technical regulation No. 15

Worldwide harmonized Light vehicles Test Procedure

Established in the Global Registry on 12 March 2014

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations

Working Party on Pollution and Energy

Sixty-seventh session
Geneva, 14 November 2013

Item 2 of the provisional agenda
Worldwide harmonized Light vehicles Test Procedures (WLTP)

Proposal for a new UN Global Technical Regulation on Worldwide harmonized Light vehicle Test Procedures (WLTP)

Submitted by the experts from the European Commission and Japan

WLTP Development under WP.29
Giovanni D’Urbano, 02.07.2014
Objectives of WLTP

2. This initiative responded to the interest of vehicle manufactures in the global harmonization of vehicle emission test procedures and performance requirements, since the compliance with different emission standards in each region creates high burdens from an administrative and vehicle design point of view. For regulatory authorities, this initiative aimed to offers opportunities for a more efficient development and adaptation to technical progress, it encourages collaboration on market surveillance and it facilitates the exchange of information.

3. The test procedure was also expected to be capable to represent typical driving characteristics around the world. This aimed to respond to the increasing evidence demonstrating that, mainly because of the exploitation the flexibilities available in current test procedures and the introduction of fuel consumption reduction technologies which show greater benefits during the cycle than on the road, the gap between the reported fuel consumption from certification tests and the fuel consumption during real-world driving conditions has increased over the years.

4. Since the beginning of the WLTP process, the European Union had a strong political objective set by its own legislation (Regulations (EC) 443/2009 and 510/2011) to develop a new and more realistic test cycle by 2014. This very aspect has been a major political driving factor for setting the time frame of the phase 1 of the WLTP development.

WLTP Time Schedule

Figure 3-3 The time schedule for Cycle development
Organisation & Structure

- The Development of the worldwide Harmonized test Cycle (DHC) group aims to develop the WLTC
- The Development of Test Procedure (DTP) group aims to develop the test procedure
- The Validation Task Force team aims to manage the validation test phase 2

Figure 3-1 The structure of WLTP-IG
Tasks of the WLTP Subgroups

Figure 3-2  Overview of the WLTC development
Cycle Development Process

Figure 4-1  Overview of the cycle development process
Since the start of the vehicles’ in-use data collection and analysis, it became clear that a worldwide harmonization based on the concept of Urban, Rural and Motorway roads was not feasible. When the Indian and the USA data were added to the database, this became even more evident.

To solve this problem the WLTP working group decided to move from the Urban, Rural, Motorway approach to the Low, Medium, High (and extra-High) speed phases.
This is the outcome of a series of comparisons to find the speed phase limits that would provide the best results in terms of similarity among the different regional databases. It was found that the best solution was:

- Low speed < 60 km/h
- Medium speed < 80 km/h
- High speed < 110 km/h
- Ex-High speed > 110 km/h
WLTP Development under WP.29
Giovanni D’Urbano, 02.07.2014
Comments/observations:

• In the Low speed phase the weight is of the same order of magnitude for Asia, Europe and USA. As the characteristics of the EU database (v, a, v*a, etc.) are mid-way between Asia and USA, the resulting WWW database lies very close to the EU db.

• To a lesser extent this is true also for the Medium speed phase.

• For the High and Extra-High speed phases, the situation is different. The Asian weighing factor is very low, thus the WWW database is necessarily in between the USA db on the one hand and the EU db on the other hand.
Once the WWW database was finalized, the WLTP speed profile was derived with the objective to fit at best the characteristics of the WWW db.

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
<th>ExHigh</th>
</tr>
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<td><img src="image2" alt="Graph" /></td>
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<td>WLTC v2</td>
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<td><img src="image10" alt="Graph" /></td>
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<td>WLTC v4</td>
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<td>Proposed</td>
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<td><img src="image19" alt="Graph" /></td>
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<tr>
<td>WLTC v6</td>
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<td><img src="image23" alt="Graph" /></td>
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WLTP Development under WP.29
Giovanni D'Urbano, 02.07.2014
Considering the constraints (duration and mileage of the lab test, drivability of the cycle), the adopted WLTP speed profile (WLTP Class 3.2) can be considered as a remarkable result in general, the more so for the EU. Some (unavoidable) discrepancies appear in the Extra-High speed phase, but they are the lowest possible.
WLTP Development – new cycle WLTC

WLTC-ver.5
(Validation 2 is currently being conducted)
WLTP DTP

Source: EMPA
Implementing the WLTP in EU legislation

Application of test requirements for type-approval and extensions

<table>
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<tr>
<th>Vehicle category</th>
<th>Mono fuel</th>
<th>Bi fuel (*)</th>
<th>Flex fuel (*)</th>
<th>Flex fuel</th>
<th>Mono fuel</th>
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<tr>
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<td>LPG</td>
<td>NG/Biogas</td>
<td>Hydrogen</td>
<td>Petrol (E5)</td>
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<td>Gaseous pollutants (Type 1 test)</td>
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<td>Yes</td>
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<tr>
<td>Particulates (Type 1 test)</td>
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<td>—</td>
<td>Yes (direct injection) (petrol)</td>
<td>Yes (direct injection) (petrol)</td>
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<td>Idle emissions (Type 2 test)</td>
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<td>Durability (Type 5 test)</td>
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<td>Low temperature emissions (Type 6 test)</td>
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<td>Yes (petrol)</td>
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<td>In-service conformity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (both fuels)</td>
<td>Yes (both fuels)</td>
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<tr>
<td>On-board diagnostics</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes (both fuels)</td>
<td>Yes (both fuels)</td>
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<tr>
<td>CO₂ emissions and fuel consumption</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes (both fuels)</td>
<td>Yes (both fuels)</td>
</tr>
<tr>
<td>Smoke opacity</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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WLTP Development – What is new?
NEDC vs. WLTP Comparison

- Chassis dynamometer inertia mass setting equivalent to the vehicle test mass (replaces discrete inertia steps).
- Lower setpoints as well as tolerances (rolling resistance, test cell temp. 23°C, ...), higher vehicle test mass.
- More realistic test cycles with 4 phases, based on real driving patterns.
- Different executions of the WLTC allow use for different vehicle power classes.
CO₂ Factor dependent of Vehicle Mass, Tyre Rolling Resistance and Aerodynamics

Graph: WLTP Draft Technical Report (version 3)
Road Load Determination

More stringent requirements imposed on the test vehicle and test track used in determining the representative road load:

- Requirements and tolerances with respect to the road load determination procedure are strengthened and improved:
  - The test vehicle and tyre specifications must be similar to those of the vehicle that will be produced;
  - Test tyre preconditioning are more stringent (tread depth, tyre pressure, run-in, shape, no heat treatment allowed, etc.) to more closely match the tyre conditions on production vehicles;
  - Use of on-board anemometry will be permitted, and the correction method applied for wind during the coast-down method is improved (both for stationary wind measurement as for on-board anemometry);
  - Special brake preparation to avoid parasitic losses from brake pads touching the brake discs will be prevented;
  - Test track characteristics (e.g. road inclination) will be more stringent to reduce positive influences on the road load determination.

Source: WLTP Draft Technical Report (version 3)
NEDC vs. WLTP
Differences at chassis dyno. setting

- Duration, length and power at wheel power are higher

- Shorter idling phases, more dynamic acceleration, test cell temp. 23°C, higher test vehicle mass, higher road load

Source: EMPA Report on WLTP Validation Phase
Test Requirements for Electric and Hybrid Vehicles

For vehicles with combined energy sources and motors additional measurements and guidelines are necessary:

• Measurement with full battery
• Measurement with empty battery for electric hybrid vehicles with external charging (Plug-In-Hybrid, Range Extender)
• Calculation requirements for fuel consumption and electric range of electric and hybrid vehicles.
• Particularly complex are the calculations for Plug-In-Hybrids
  o Powertrain: ICE + electric engine
  o Energy sources: Gasoline + self generated current + external current
• Utility Factor: determines the part of pure electric driving on a Plug-In-Hybrid.

Background: Deutsche Bundesregierung / Tybussek; source: www.bundesregierung.de
Test Requirements for Electric- und Hybrid Vehicles
Further Developments and Implementation

Possible WLTP implementation in the EU:

• EU plans an implementation from 2017 on. The CO₂ target for 2020 should be met on WLTP (currently 95 g/km based on NEDC).

Further steps in WLTP development:

• **Phase 1 (2009 - 2014):** Development test cycle and procedure (GTR Nr. 15)

• **Phase 1b (2014-2015):** Clarification of detail questions on electric vehicles, certification, secondary emissions (N₂O, NH₃, …),

• **Phase 2 (2016 - 2018):** Low temperature, utility factor, durability, on-board-diagnostics (OBD), mobile air conditioning, real-driving emissions (RDE)

• **Phase 3 (2018 - …):** Emission limits and OBD thresholds, definition of reference fuels, comparison with regional regulations
Thank you for your attention!