Latest regulatory updates in road transport and pollutant emissions

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2017 a pivotal year

- In 2017 major elements were introduced in EU TA framework

  1. WLTP replaced the NEDC as the reference test protocol
  2. RDE emissions test became mandatory for regulated pollutants

- WLTP applicable for pollutant emissions regulation, Euro 6 limits remain
- Due to a provision in the pre-existing regulation for CO₂ NEDC values are still used for CO₂ target compliance evaluation (through the correlation process); CO₂ emissions still communicated for the NEDC
- NOₓ and PN emissions are checked over an RDE with PEMS
### Difference between NEDC and WLTP

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>in NEDC</th>
<th>in WLTP</th>
<th>Impact on CO\textsubscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road Load Determination</strong></td>
<td>Vehicle test mass</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
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<tr>
<td></td>
<td>Tire selection</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
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<td></td>
<td>Tire pressure</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
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<tr>
<td></td>
<td>Tire tread depth</td>
<td>Present</td>
<td>Modified</td>
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<td></td>
<td>Calculation of resistance forces</td>
<td>Present</td>
<td>Corrected</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Inertia of rotating parts</td>
<td>Absent</td>
<td>Introduced</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Laboratory test</strong></td>
<td>Driving cycle</td>
<td>Present</td>
<td>Modified</td>
<td>±</td>
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<td></td>
<td>Test temperature</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
</tr>
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<td></td>
<td>Vehicle inertia</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
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<td></td>
<td>Preconditioning</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Gear Shift strategy</td>
<td>Present</td>
<td>Modified</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Post-processing test results</strong></td>
<td>SOC correction</td>
<td>Absent</td>
<td>Introduced</td>
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</tr>
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<td></td>
<td>Correction of speed and distance</td>
<td>Absent</td>
<td>Under discussion</td>
<td>±</td>
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<tr>
<td><strong>Declared value</strong></td>
<td>Declaration of CO\textsubscript{2} emissions</td>
<td>Present</td>
<td>Modified</td>
<td>↑</td>
</tr>
</tbody>
</table>

- The WLTP is expected to have a significant effect on certified CO\textsubscript{2} emissions
- Wider area of engine operation covered by WLTP → Euro 6 limits respected over broader conditions
NO\textsubscript{X} & CO\textsubscript{2} from Type Approval to Real world (1/2)

Diesel vehicles tested @ JRC over different conditions

- **CO\textsubscript{2}**:  
  - Type-approval avg = 127 g/km  
  - NEDC avg ~ 145 g/km  
  - WLTP avg ~ 160 g/km  
  - Road avg ~ 170 g/km

- **NO\textsubscript{X}**:  
  - In NEDC, average emissions are around the regulated limit of 80 mg/km, while for WLTP, the values double the limit (~170 mg/km). On road tests show more than 400 mg/km in avg.  
  - SD shows big variability among vehicles, especially in WLTP and on road tests.
**NO\textsubscript{x} & CO\textsubscript{2}: from Type Approval to Real world (2/2)**

Gasoline vehicles tested @ JRC over different conditions:

- **CO\textsubscript{2}:**
  - 20% gap measured NEDC vs TA NEDC
  - WLTP + 10 g/km than NEDC CO\textsubscript{2}
  - On-road +30-40% more CO\textsubscript{2} than TA NEDC

**NO\textsubscript{x}:**
Generally below the regulated limits of 60 mg/km.

- Only one vehicle showed higher values for WLTP, especially when tests were performed at −7 ° C.
Correlated CO\textsubscript{2} emissions (1/2)

Due to pre-existing regulation NEDC CO\textsubscript{2} values are still reported for targets evaluation purposes

- Final CO\textsubscript{2} a product of OEM declaration verified by CO\textsubscript{2}MPAS or physical tests

- correlated CO\textsubscript{2} ≠ CO\textsubscript{2}MPAS CO\textsubscript{2}
Correlated CO₂ emissions (2/2)

- Reports of increased NEDC CO₂ as a result of the correlation process
- This is due to a series of boundary conditions and protocol related issues being linked to the WLTP or more clearly defined
- JRC’s estimates suggest that reported CO₂ values might increase for some vehicles after 2017 up to 12% coming closer to the “spirit” of the NEDC test protocol

- RL determination and Declaration factors reflected to Cor. NEDC
  - Road loads linked to WLTP ones
  - Test temperature fixed at 25 C
  - Results declaration

Pavlovic et al. 2017
CO₂ emissions and Reality

- Assuming a hypothetical “average” vehicle, the gap could be attributed to a series of factors.
- Tests conducted on different vehicles confirmed previously reported variability range.
New Type-approval framework

The European Parliament, the Council and the Commission reached a political agreement to significantly raise the quality level and independence of vehicle type-approval and testing

- **Raises the quality level and independence of type-approval and testing before a car is placed on the market.** Regular audits of technical services and TA authorities
- **Increase checks of cars that are already on the EU market.** Member States can now act against non-compliant vehicles without waiting for granting TA authority
- **Introduces more Commission oversight.** COM to carry out market checks independently of Member States and may initiate EU-wide recalls and impose fines
Real Driving Emissions Regulation in brief

Why? Secure on-road emissions in real world driving throughout the normal life of light duty vehicles (passenger cars & light commercial).

What? NO\textsubscript{X} and PN emissions assessment of ICE, NOVC-HEVs, OVC-HEVs with on-board Portable Emissions Measurement Systems (PEMS).

How? PEMS: gas & particle analyzers, exhaust flow meter, GPS antenna. PEMS validation against laboratory CVS: max tolerances are defined.

When? At type approval and for In-Service Conformity (vehicles up to 5 years/100,000 km with appropriate maintenance).

Where? over an RDE compliant route: urban/rural/motorway drive, boundaries are set for driving dynamics, altitude gain, payload, ambient T, etc.

Who? Type Approval Authorities for TA tests + certified bodies for 3rd party testing.
Real Driving Emissions Regulation in the EU

RDE is based on Not-To-Exceed (NTE) principle and it takes into account PEMS measurement uncertainty (Conformity Factor). Annual review for CF to bring it down to one (if possible).

\[ \text{NTE}_{\text{pollutant}} = \text{CF}_{\text{pollutant}} \times \text{EURO-6} \]

RDE Regulation developed in 4 regulatory packages. RDE in force at type approval since September 1\textsuperscript{st} 2017

RDE1: Regulation 2016/427 (31.3.2016) → Procedure description
RDE3: Regulation 2017/1154 (7.7.2017) → CF PN + cold start + OVC-HEV
RDE4: Regulation 2018/XXX (Spring 2018) → ISC + evaluation update
Ex-post evaluation

Raw data (i.e., as measured by the PEMS), is subjected to an ex-post evaluation aiming at:

- checking that the trip requirements are fulfilled: distance in URB/RUR/MOT; cumulative altitude gain; stop time; min temperature; etc.
- checking the trip validity, that is guaranteeing that the vehicle was operated in a way which corresponds to its typically intended use at real driving on the road → MAW
- calculating final RDE distance-specific NO\textsubscript{X} and PN and compare with NTE limits (Tot/Urb).

Moving Averaging Window

\[ \text{tol}_{1H} = +45\%/40\% \]
\[ \text{tol}_{1L} = -25\% \]

WLTP CO\textsubscript{2} L/H/X-H

Euro 6D-TEMP: \( RF_{L1} = 1,20 \) and \( RF_{L2} = 1,25 \);
Euro 6D: \( RF_{L1} = 1,30 \) and \( RF_{L2} = 1,50 \);
RDE as source of emission factors

3.1.3. Reporting and dissemination of RDE type approval test information

- The manufacturer shall ensure that the final RDE result is made available on a publicly accessible website without costs and without the need for the user to sign up by entering one or more of the following: Make, Type, Variant, Version, Commercial name, or TA number.
- A technical report prepared by the manufacturer shall be made available to the approval authority including mandatory (1 Hz NO/NO₂/CO/CO₂/PN emissions, exhaust flow rate, ambient T, ambient humidity, GPS speed, GPS altitude) and optional parameters (engine speed, engine coolant T, engine torque, fuel flow, etc.) → “Upon request, without costs and within 30 days, the manufacturer shall make available the technical report to any interested party”.

JAMA http://www.jama-english.jp/europe/publications/rde.html

Note: probably best case scenarios
Will RDE regulation ensure low NO\textsubscript{x}/PN emissions under real life conditions?

The Unearthed investigation obtained on-road test results from the EU’s 20 leading car brands, for every new diesel model approved for sale during the monitoring period. The findings show:

- More than half – 51% – of the new diesels put through the test between April 2016 and September 2017 recorded on-road NO\textsubscript{x} emissions above the 168mg/km limit allowed for new models seeking approval today.

- However, some manufacturers are already producing vehicles that perform much better than RDE rules require. BMW, Mercedes, Kia, Peugeot, Vauxhall, and Volvo have all had vehicles approved since April 2016 that stay well below the 80mg/km Euro 6 limit in on-road testing – meaning they emit a small fraction of the maximum allowed under the current RDE limit. In some tests, these cars kept emissions below 10mg/km (0.1 times Euro 6). These companies are also the first to bring out diesels approved under the tougher standards that have been in place since September.
Reasons to consider a Euro 7 standard

RDE + WLTP may effectively be “Euro 6.5” standard... **BUT** we need a Euro 7 regulation (possibly the last “Euro” step?) for the open issues that could not be addressed by delegated/implementing acts.

European Parliament has called for a proposal of “new technology-neutral Euro 7 emission limits applicable by 2025 for all light-duty vehicles “
Could Remote Sensing have a bigger role in the future EU emissions regulations?
Thank you for your attention!