



The development of RDE in Europe

RDE IWG kick off meeting
11 September 2018

A quick history of EU- RDE: packages 1 to 4

EURO 6 Regulation on emissions:

- *The technical measures taken by the manufacturer must be such as to ensure that the **tailpipe and evaporative emissions are effectively limited, .. throughout the normal life of the vehicles under normal conditions of use.** Therefore, in-service conformity measures shall be checked for a period of up to five years or 100 000 km, whichever is the sooner.*

And

- *The **use of defeat devices** that reduce the effectiveness of emission control systems shall be **prohibited.***
- *'defeat device' means any element of design which senses temperature, vehicle speed, engine speed (RPM), transmission gear, manifold vacuum or any other parameter for the purpose of activating, modulating, delaying or deactivating the operation of any part of the emission control system, that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use;*

Review of EURO 6 Regulation

*(15) The Commission should keep under review the need to revise the New European Drive Cycle as the test procedure that provides the basis of EC type approval emissions regulations. **Updating or replacement of the test cycles may be required to reflect changes in vehicle specification and driver behaviour.***

*Revisions may be necessary to ensure that real world emissions correspond to those measured at type approval. **The use of portable emission measurement systems and the introduction of the 'not-to-exceed' regulatory concept should also be considered.***

History of PEMS testing at JRC

2004:

- PEMS testing of HDV at JRC

2007:

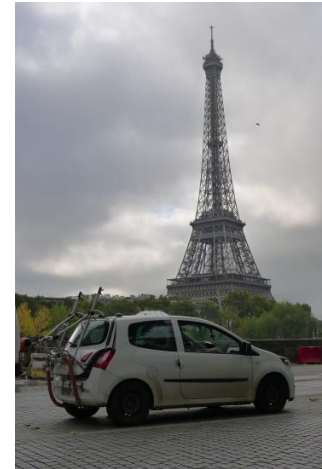
- PEMS tests of Euro 3 and 4 light-duty vehicles
- Focus on diesel vehicles due to NO₂ air quality problems

2009 – 2010:

- First on-road test of a Euro 5 light-duty vehicle
- End of experimental campaign with a total of 12 Euro 3-5 light-duty diesel and gasoline vehicles tested
- Presentation of results to Member States and other stakeholders

PEMS testing of other vehicles:

- Since 2008 PEMS testing of non-road mobile machinery
- Since 2015: L-category vehicles with mini-PEMS



RDE developments in Europe



January 2011:

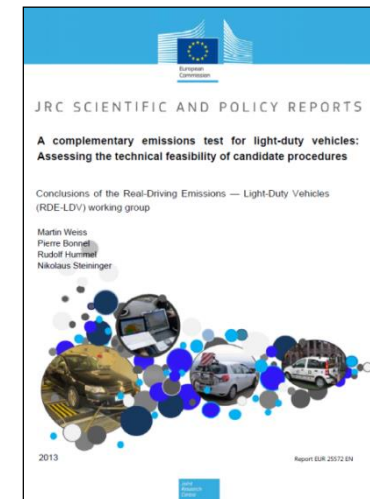
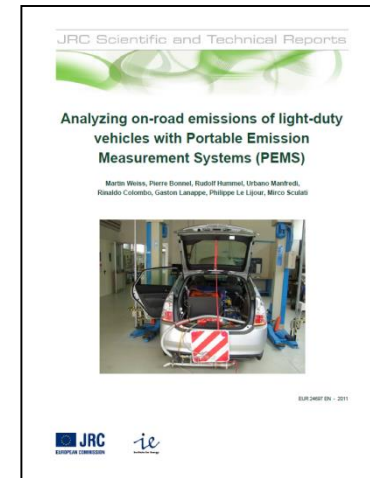
- Report: Elevated on-road NOx emissions of diesel cars
- Kick-off meeting of the Real-Driving Emissions (RDE) working group

2011 and 2012:

- Evaluation of four candidate procedures:
 - Complementary fixed driving cycles
 - Emissions modeling
 - Random driving cycles
 - PEMS on-road testing (JRC)
- In-depth evaluation of random test cycles and PEMS on-road testing

October 2012:

- PEMS on-road testing chosen for complete development of a regulatory RDE procedure



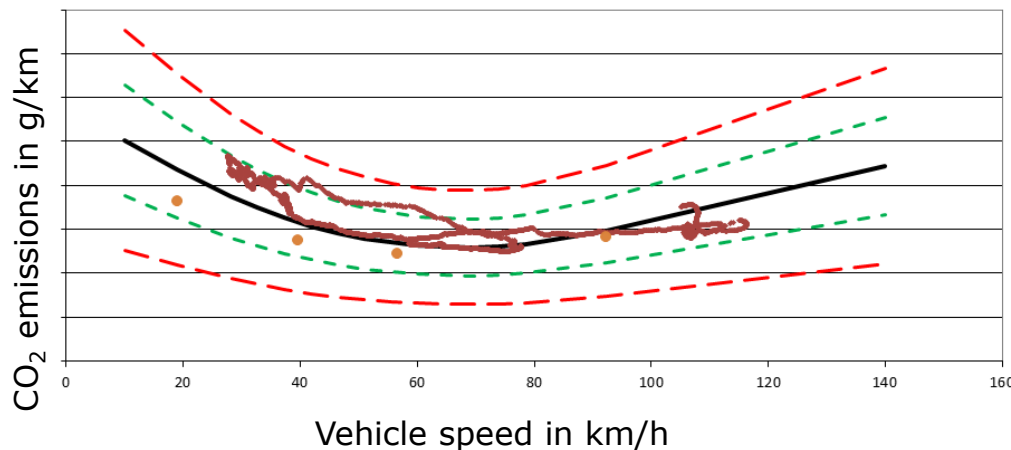
RDE developments in Europe



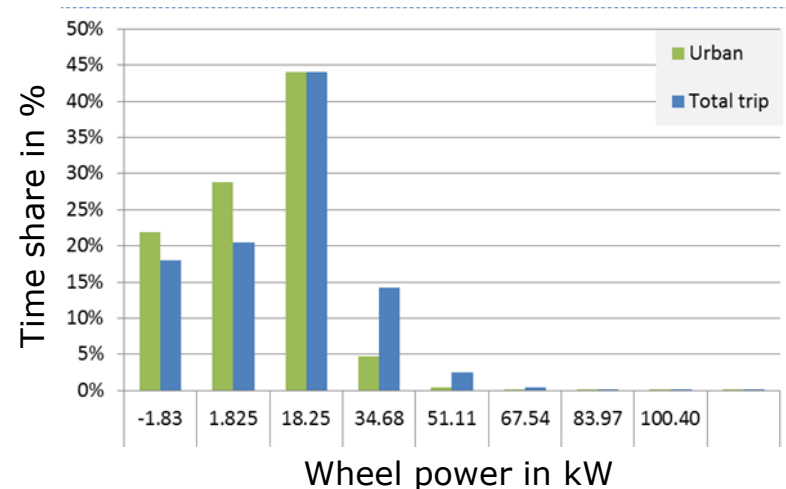
2012-2015:

- Assessment of three data evaluation methods:
 - Speed-binning (proposed by TNO)
 - Moving averaging window analysis (proposed by JRC)
 - Power-binning (proposed by TU Graz)
- Development of Moving averaging windows (JRC) and Power-binning (TU Graz)
- Development of a PEMS testing protocol;
- Pilot program to assess the feasibility of PN-PEMS

Moving average windows



Power binning



RDE developments in Europe



2016:

- Development of RDE Regulations 2016/427 (RDE1) and 2016/646 (RDE2) as first on-road test procedure for emission type approval worldwide
- NOx Conformity factor 2.1 – applicable from Sept. 2017/2019 (new types/all new vehicles)
- NOx Conformity factor 1.5 – applicable from Jan. 2020/2021 (new types/all new vehicles)
- Compliance during urban driving and the entire RDE trip

RDE developments in Europe



2017:

- RDE 3rd Package (Regulation (EU) 2017/1154) was introduced as part of Regulation 2017/1151 (*the WLTP Regulation*)
 - Testing of hybrid vehicles, coverage of cold-start and regeneration events, particle number emissions
 - PN Conformity factor 1.5 – applicable from Sept. 2017/2018 (new types/all new vehicles)

2018:

- RDE 4th Package:
 - Provisions for in-service conformity
 - Reviewing RDE procedure
 - Adapting provisions to ensure practicality and effective emissions testing
 - New Validation criteria that work with hybrids
 - New simple and transparent evaluation method
- RDE 4 was voted positively in the Technical Committee and will become EU law by the end of 2018

RDE Document repository:

All documents presented during the development of RDE in Europe can be found in:

For RDE1 to RDE2:

<https://circabc.europa.eu/w/browse/41afbc5e-c579-4b91-a0fe-95d58493407b>

For RDE3 and RDE4:

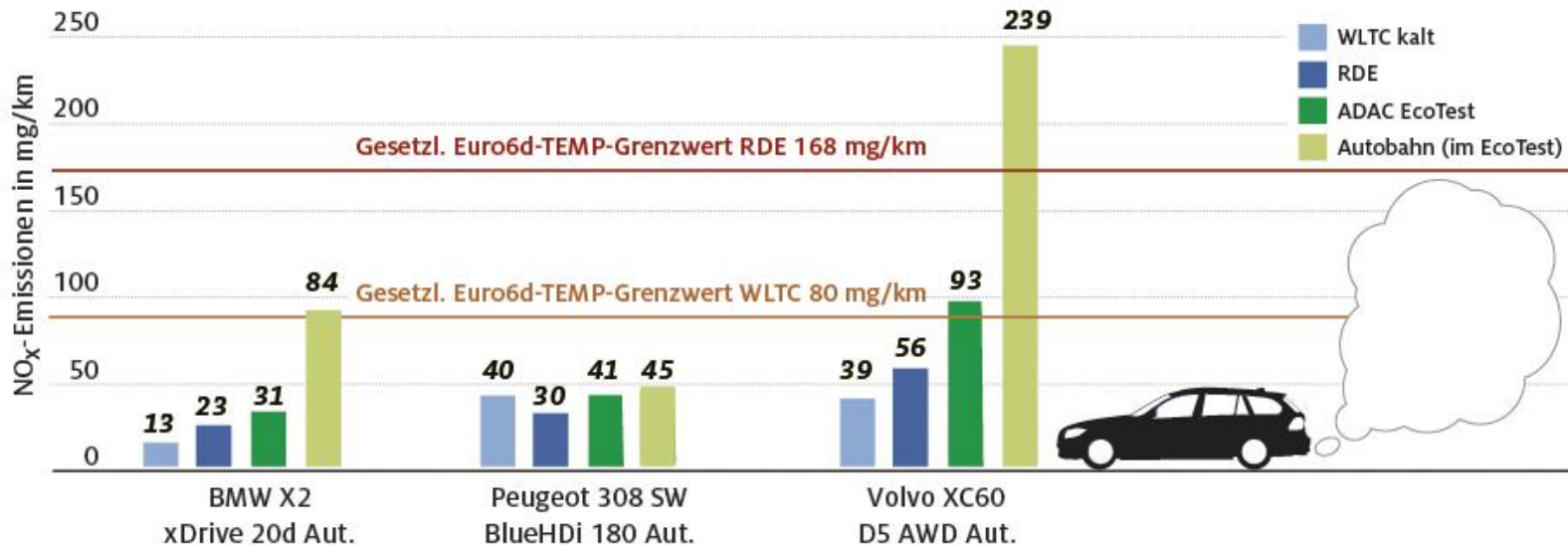
<https://circabc.europa.eu/w/browse/cfc48b58-66a9-489a-a339-6ef468b63add>

Legal texts:

- *RDE1: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R0427>*
- *RDE2: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R0646>*
- *RDE3: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L .2017.175.01.0708.01.ENG>*
- *RDE4: on RDE IWG wiki*

The post-RDE era (EURO6d-temp vehicles):

NO_x-Ausstoß in den EcoTest-Messungen



**Tests performed by ADAC*

(<https://www.adac.de/der-adac/rechtsberatung/fahrzeugkauf-und-verkauf/abgasskandal-dieselthematik/test-euro-6-temp/>)



Thank you for your attention!

P. Dilara
Clean Vehicles Team Leader

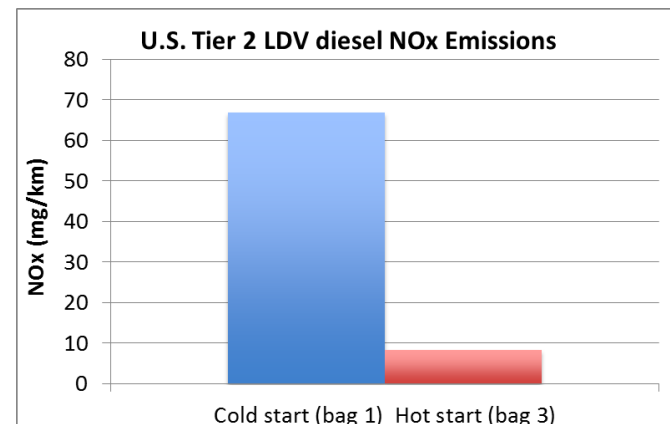
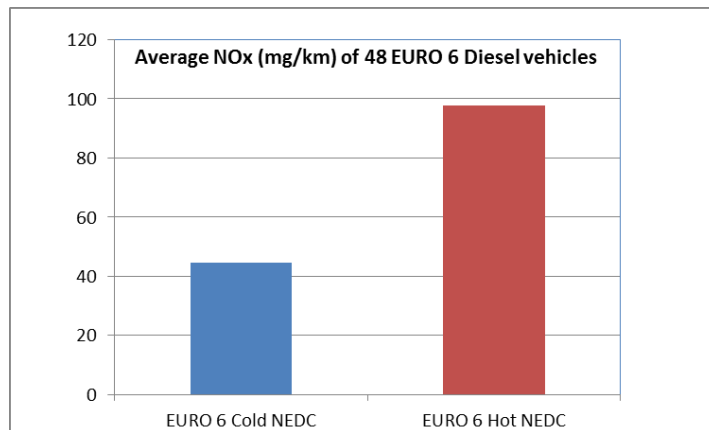
ADDITIONAL SLIDES

Cold /hot start

Data collected in Europe showed a strange trend: emissions of vehicles with hot engine were higher than emissions with cold engine

Solution:

A % of RDE trips shall be executed with hot engine



Guidance on AES/BES and Defeat Devices

Stronger clauses for the approval of Auxiliary Emission Strategies (AES) in legislation

Complete with Guidance

Adopted on 26 January 2017 in Europe.

- **AES/BES approval details and methodology**
- **Testing for Defeat Devices**
- **Regularly updated**
- **Concrete examples**



Testing for detecting DD before RDE

- In **category 1**, the testing is conducted in a laboratory under a controlled environment with only limited changes when compared to the legislative cycle and the modified parameters can be controlled. **The modification of the testing conditions should not lead to a significant change in the physical response of the engine system.** Examples of such modifications include testing vehicles with an open door or rolled-down windows.
- In **category 2**, the testing is conducted in a laboratory or on the road with conditions different than the legislative cycle and the value of the modified parameters can be controlled (e.g. driving a legislative cycle on a test track). The modification of the testing conditions **may in some cases lead only to a limited change in the physical response of the engine system.** Examples of such modifications include variations in the test temperature, the execution of hot-start tests, and the repetition of selected phases of the test cycle.
- In **category 3**, the testing is conducted on the road and the values of the modified parameters are - to a large extent - uncontrolled (e.g. the vehicle speed due to the traffic, the temperature, etc...). The modification of the testing conditions **may lead to a significant change in the physical response of the engine system(s).** The magnitude in the change of the emissions may depend on the severity of the testing conditions. Examples of such modifications include testing at various test routes characterised by a distinct altitude profile, such as the RDE compliant testing. Multiple RDE testing, would also allow to detect possible presence of defeat devices.
- A **category 4** is added in order to allow for "**surprise testing**" to cover testing that does not fall in any of the above categories, but may still be needed in order to detect a possible defeat device, for example in the case of evaporative emissions testing.
Engine and the emissions control system(s)

Possibilities with RDE

- *Any RDE test should be below NTE limits*
- *Any variation that is not fully compliant within RDE requirements may still be searched for DD*
- *Any surprise testing in the lab or road as before*

Is there still a relationship between CO2 and pollutants?

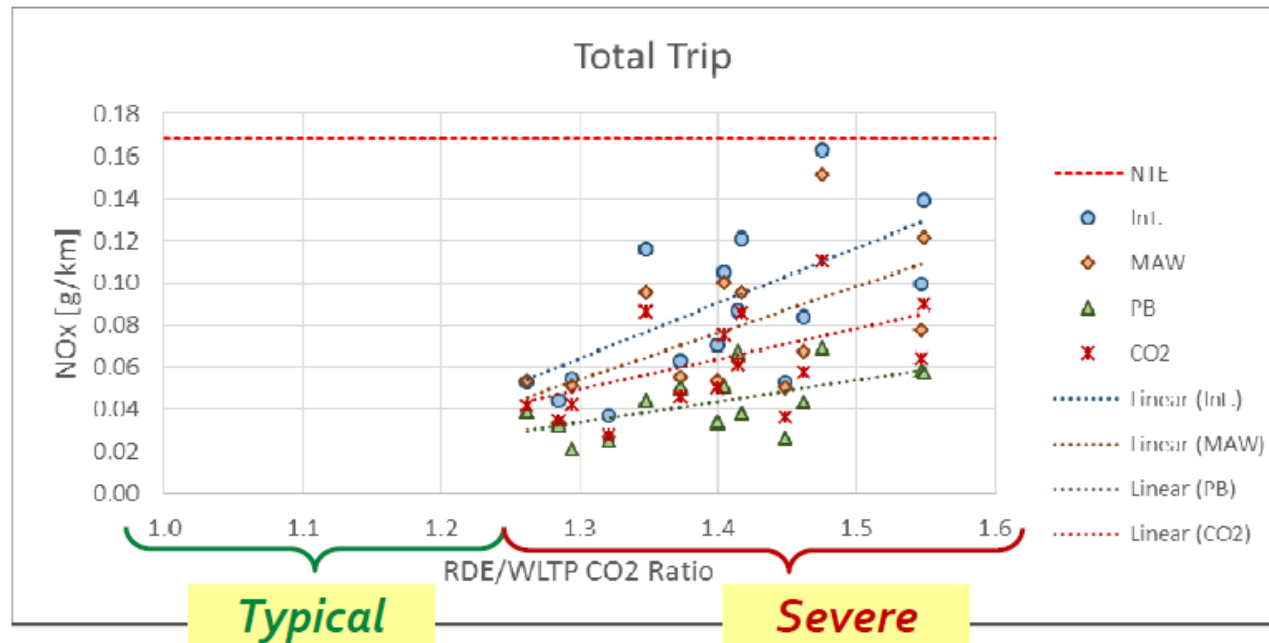
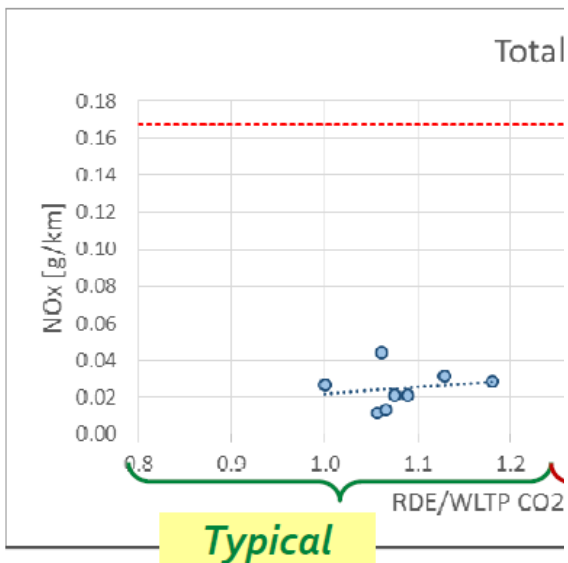
Pollutants during extreme tests (heavy loads, uphill, low T, etc) pollutants still increase with CO2



JRC DATA (DIESEL – EGR, LNT, SCR) – EC



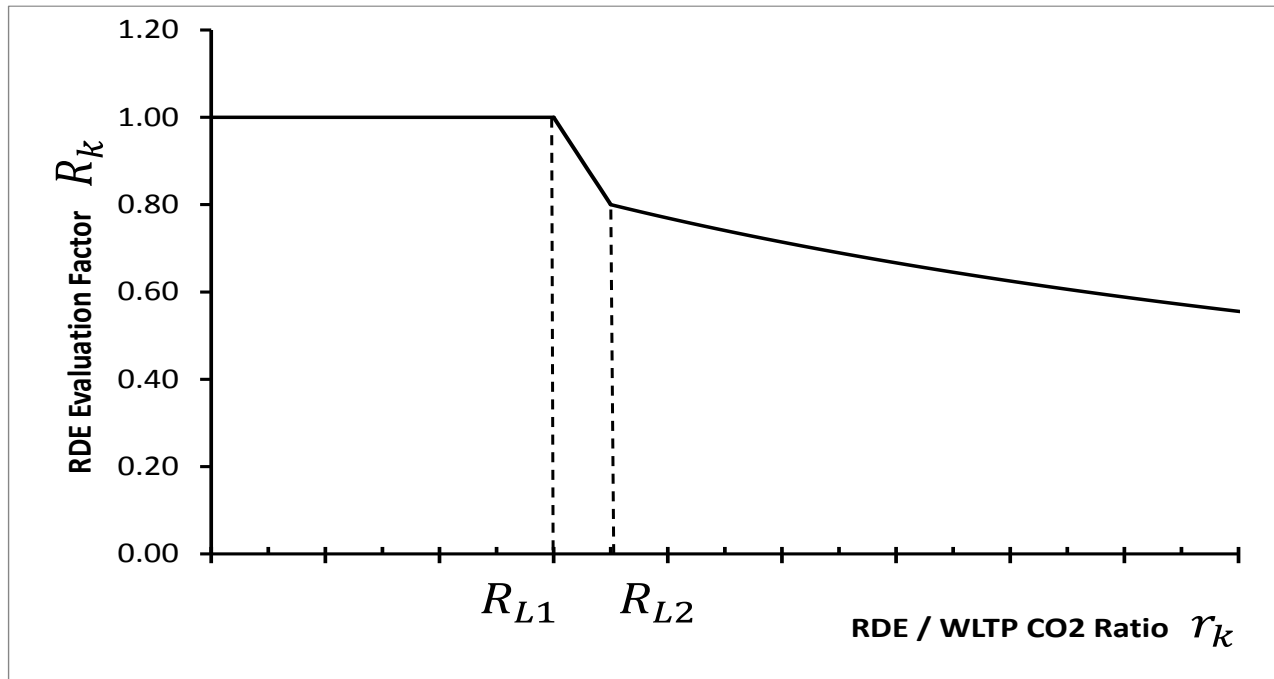
Eu6d-TEMP VEHICLE DATA: VEHICLE "D1" (DIESEL – EGR, DOC, SCRf)



Emissions Calculations

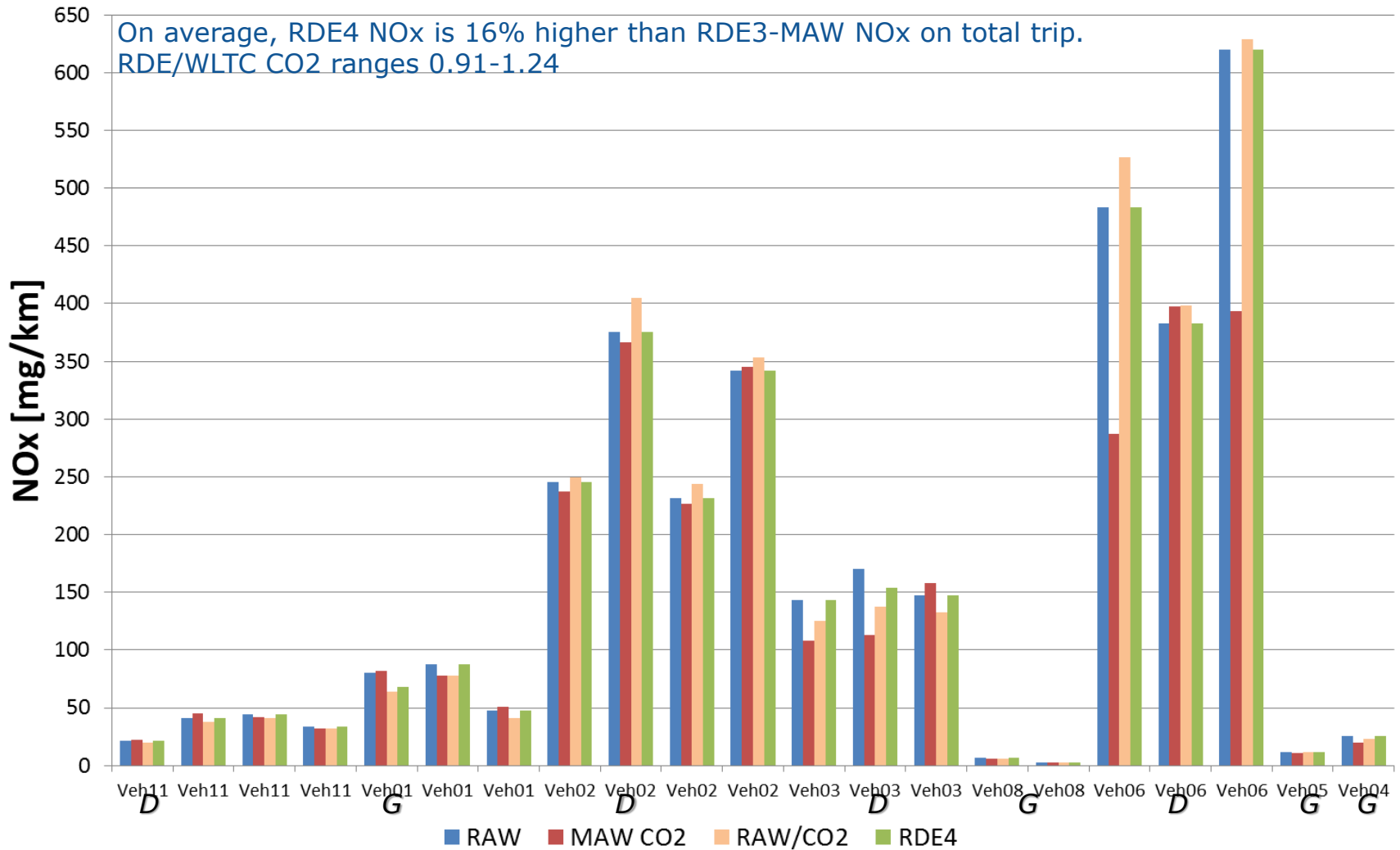
RDE 1st step (before 1 January 2020): $RL1=1.2$, $RL2=1.25$

RDE 2nd step (after 1 January 2020): $RL1=1.3$, $RL2=1.50^$*



Total trip NOx emissions [mg/km]

On average, RDE4 NOx is 16% higher than RDE3-MAW NOx on total trip.
RDE/WLTC CO2 ranges 0.91-1.24



Urban trip NOx emissions [mg/km]

On average, RDE4 NOx is 36% higher than RDE3-MAW NOx on urban trip.
RDE/WLTC CO2 ranges 0.78-1.22

