the shift towards emission factors based on-road measurement data

THE SHIFT TOWARDS EMISSION FACTORS BASED ON-ROAD MEASUREMENT DATA

ERMES WG PEMS measurements | Norbert E. Ligterink

REAL WORLD TESTING (RDE)
FOR COMPLIANCE AND REAL WORLD PERFORMANCE

- Many laboratories are now using **RDE testing protocols** as standard for on-road PEMS testing:
  - Member states, UNECE, European Commission, European Parliament, and stakeholders interested in effectiveness RDE legislation
  - Monitoring data from type-approval process, ADAC, etc. show good performance of Euro-6d-TEMP vehicles.
  - DG GROW contracted for ISC RDE testing by TNO-led consortium (with LAT, Emisia, DTI, TuV-Nord, VTT, ICCT (and possibly Horiba)).
- "**Outside RDE**" is seen as the domain of "defeat devices 2.0" with declared control strategies "AES" as a safeguard, in the type-approval process.

RDE TESTING BY LABORATORIES
WITHIN ERMES AVAILABLE DATA

- **TuV-Nord, for Swedish IUC test programme**
  - with the different stages of RDE legislation
  - 30+ vehicles tested
- **DfT, for UK type-approval compliance**
  - data publicly available, limited information
- **TNO, for RDE legislation development and IUC test programme**
  - mainly SEMS data, 2 or 3 RDE tests as part of a 3-day test program
  - 40+ Euro-6 vehicles tested and monitored
- **LAT/EMISIA, independent testing**
  - 18 vehicles, also petrol, LPG, and CNG
- **TUG, testing for RDE legislation, testing for PEMS robustness**
  - development of a PEMS test bench

IS EURO-6D-TEMP CLEAN?
AND EURO-6D CLEANER?

- Low **NOx** observed for **diesel vehicles** (~10-100 mg/km on road)
- GPF standard on **petrol GDI** decimated **PN** emissions (from ~ 5 x 10^{12} #/km)
- Other components and technologies are not covered by RDE
- Euro-5/6 legislation has further limitations:
  - No N_2O, no NH_3, up to 5 years and 100,000/160,000 km, etc.
- RDE is for the "urgent" problems, post Euro-6 should be more comprehensive

Norbert E. Ligterink

the shift towards emission factors based on-road measurement data

PEMS TESTING AND RESULTS

- **How to use and trust PEMS test results?**

- limited repeatability and reproducibility
  - repeat testing shows in a number of cases large variations
- limited on-road validation of PEMS
  - PEMS is validated mainly in the laboratory, with laboratory conditions
- limited control on test execution
  - traffic may vary, stops and velocity cannot be prescribed
- limited control on test conditions
  - ambient temperature and precipitation will vary
- quality of some signals poor and poorly understood
  - GPS, particular altitude, can be very poor, almost unusable

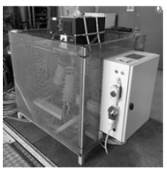
PEMS TESTING IS NON-TRIVIAL
TUG DEVELOPMENT OF BENCH TEST

- PEMS systems today are compared to lab analysers in steady state condition (no movement of the PEMS, no temperature and pressure changes as occur in real PEMS testing)
- To compare results from PEMS with lab analysers in realistic conditions, the **PET** (**P**ortable **E**mission accuracy **T**estbench) was developed.
- The PET test stand allows realistic movements of the PEMS according to acceleration profiles measured on vehicles in RDE tests. The PET can be positioned on chassis dynos or any other test stand to compare PEMS with lab analyser results while moving the PEMS.
- The PET was starting initial operation June 2018.

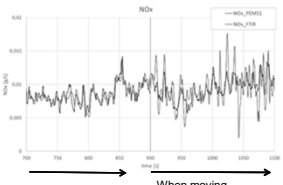
ON-ROAD VIBRATIONS INCLUDED AT TUG

- Several PEMS tested within Horizon2020 Down To Ten project

Example for worse performing system:



3 linear motors allow repeating movements from real tests



Without moving PEMS fits to lab FTIR

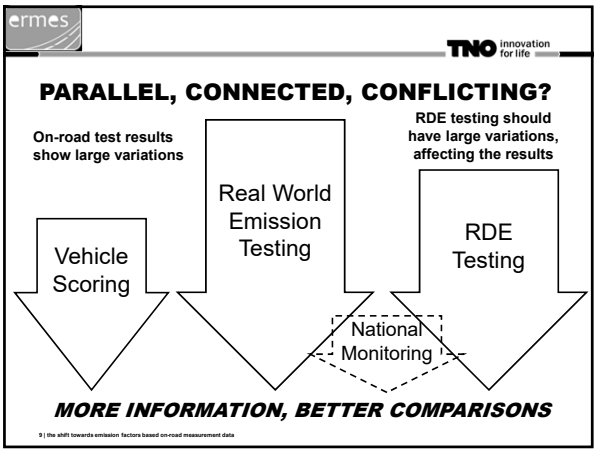
When moving PEMS shows peaks not in line with lab FTIR

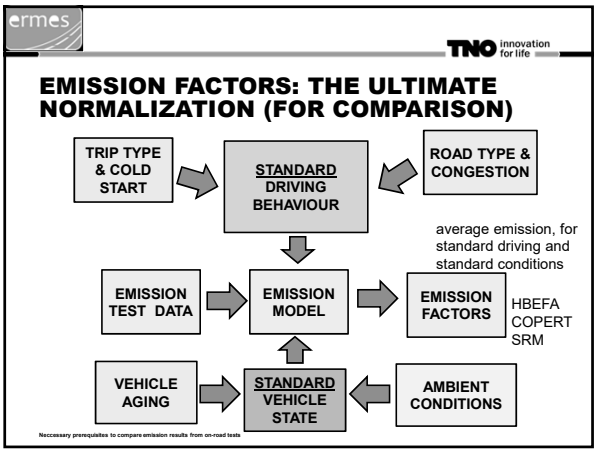
PEMS TESTING FOR RDE COMPLIANCE

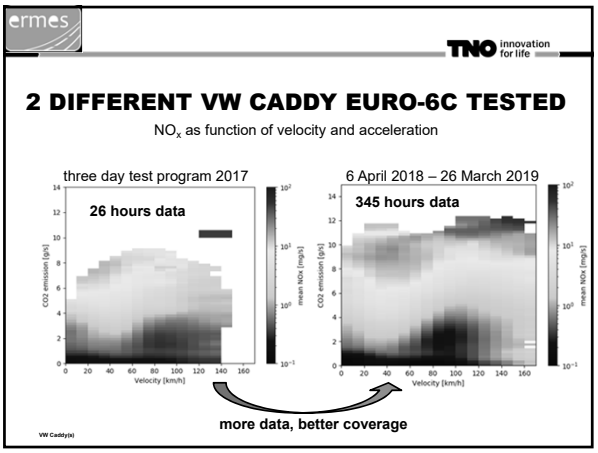
- **Accreditation for RDE according to 17020 and 17025**
  - RDE1-4 and JRC PEMS guidance
  - Independent ISC testing for type-approval and compliance
  - Evaluation protocol and tools, and restricted information platform
- **Conformity factor and the European Court**
  - NOx 80 mg/km + margin, to be readdressed
- **Margin discussion and developments**
  - CEN Work group on PEMS accuracy (Bergman (TUG) chair)
  - Margin evaluation in the EU
- **Worldwide harmonisation of RDE in UNECE**
  - Improvements possible?
- **Other testing initiatives and its stakeholders:**
  - EuroNCAP, CEN, EQUA, EcoScore, EcoTest, TRUE, DUH, ...
  - More data is better, more confusion (“only a number”) is not.

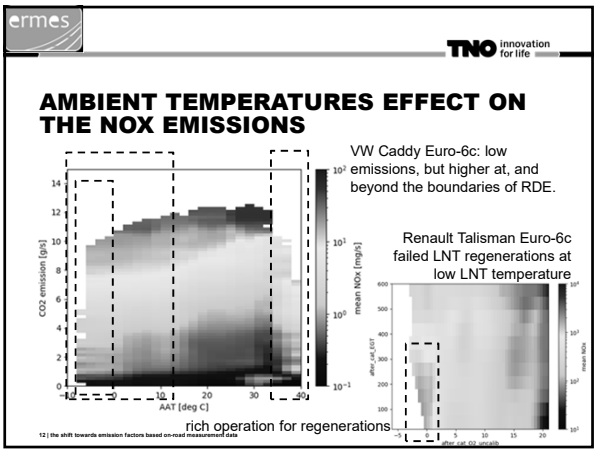
Norbert E. Ligterink

the shift towards emission factors based on-road measurement data

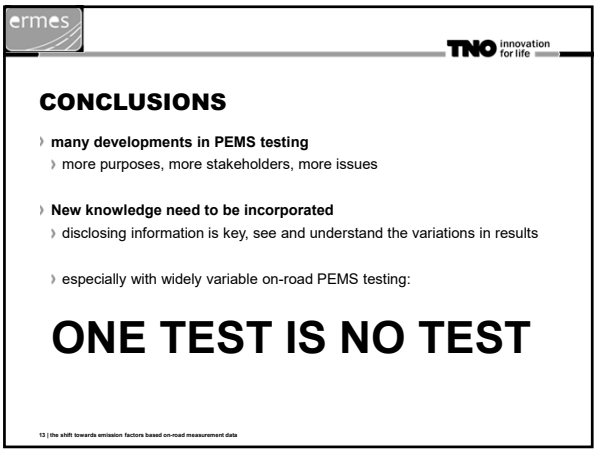


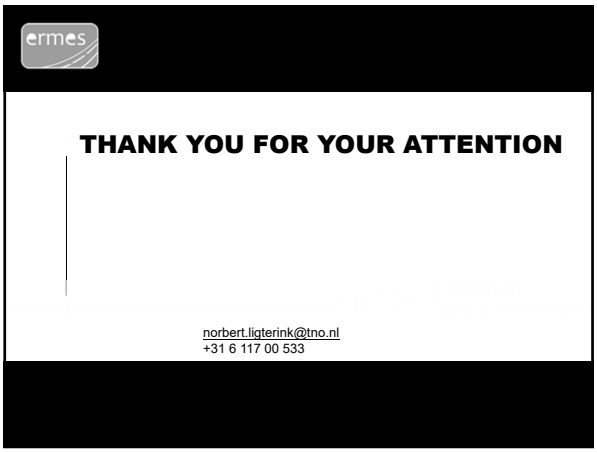






the shift towards emission factors based on-road measurement data





Norbert E. Ligterink