CONTENT

- Legislation: Updates Light Duty and Heavy Duty
- Test Execution: How to perform a valid RDE Test?
- Test Evaluation: New Features in Concerto M.O.V.E
- Development: RDE Cycles on a Chassis Dyno
- Development: RDE Cycles in the Engine Map
- Summary
### WHERE WE DRIVE & LIVE

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<th>RURAL</th>
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*Fotos: Shutterstock.com, GagliardiImages / Shutterstock.com, ABC Photo / Shutterstock.com, Wolfilser / Shutterstock.com*
## EMISSION TIMELINE: PASSENGER CARS AND LCV

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**Notes:**
- 130 and 95g/km in NEDC
- Nation wide, all based on R-83
- Cities, all based on R-83
### CHINA LEGISLATION TIMELINE: PC AND LCV

#### Light Duty Vehicles

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#### China-6 National Proposal (by VECC)

- **Date:** 2019
- **Limits 6a:** EU-6 but fuel neutral
- **Limits 6b:** 50% below EU-6
- **Drive Cycle:** GTR-15 (WLTP)
- **Procedures:** Diesel -7°C Test
- **RDE (6b):** CF: NOx 2.1, PN 1.5
  - 700 - 1300 - 2400m
- **EVAP:** 48h Diurnal at 38°C
  - “heated street”

An updated proposal will be released in June 2016 and should be finalized and released until End of 2016.

#### Beijing-VI Proposal (by EBP)

- **Date:** Dec. 2017
- **Limits:** Similar to ULEV70
- **Drive Cycle:** FTP-75
- **Procedures:** UN-ECE Reg. 83
- **RDE:** NOx CF 1.2
  - like US w/o running loss “heated street”

No: as an own legislation (FTP-75, ...), most likely.
Yes: as an earlier implementation of China-6b w/o RDE

#### China-7 Ideas

2025+ a China-7 legislation could be based on an own Chines standard. That was already discussed for China-6 including an own Chinese drive cycle.

Since limited experience in regulation making and since the “Chinese drive cycle” was quite similar to the WLTC, it was decided to stay for China-6 with the EU standard.
# EMISSION LEGISLATION – HEAVY DUTY ENGINES

## Application: Public

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Better fuel quality is a must for low emissions!
# EMISSION LEGISLATION – HEAVY DUTY ENGINES

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**Fuel quality is a must for low emissions!**

- **Euro V**
- **Euro VI**
- **Euro VII**
- **Bharat III**
- **Bharat IV**
- **Bharat V**
- **Bharat VI**

**Notes:**

- Bharat III with GTR-4 and PEMS
- Bharat VI with GTR-4 and PEMS
**TODAY: GAP BETWEEN LAB AND ROAD**

**USA: Real life emission test results**
Real life NOx and CO2 emissions from modern Diesel passenger cars: 15 cars from 6 OEMs in EU-6a or US Tier 2 Bin 5/ULEV II configuration.

**EU: Real life emission results**
Testing results in Germany from KBA (German type approval authority).

Emissions (NOx Diesel and PN Gasoline) on the road are significantly higher as in the laboratory. Today, there is little proportionality anymore between laboratory- and road-emissions.
LD RDE EU: **3rd Package** to be voted on in TCMV in 12/16
- PEMS PN: Introduction 09/2017, CF PN=1.5 for 2017 (new types)/2018 (all types)
- Cold Start, Hybrids, Regeneration, Fuel Quality

HD ISC EU:
- PEMS PN instead of PEMS PM
- Various ongoing adaptions to the test protocol and data evaluation requirements

LD US:
- PEMS is used to find cheat devices, RDE protocol?

HD US:
- Changes in the test protocol under discussion, very low emission PEMS?
- Alternative methods for data evaluation under discussion

RDE China:
- Altitude up to 2400m! Huge challenge for PEMS instruments.
CONTENT

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- Summary & Outlook
RDE BOUNDARY CONDITIONS

RURAL
- 33%
- 60 – 90km/h
- 0°C
- -7°C

CITY
- 34%
- 0 – 60km/h
- 2400m
- 1300m
- 35°C
- 30°C

HIGHWAY
- 33%
- 90 – 145 – 160 km/h
- 700m
- 30°C

Fotos: Shutterstock.com, GagliardiImages / Shutterstock.com, ABC Photo / Shutterstock.com, Wolfilser / Shutterstock.com
AVL M.O.V.E

GAS PEMS IS

CO, CO2, NO, NO2, O2

PN PEMS

Particle Number

AVL M.O.V.E EFM

Exhaust Mass Flow

AVL PLUtron™

Fuel Flow

AVL Indicating

Indicating

SYSTEM CONTROL

GPS

T, p, %

OBD II

Online Tools

Concerto M.O.V.E

Analysis

Reports

Road Importer to Lab
RDE TESTING UNDER HIGH ALTITUDE
PERFORMANCE OF GAS PEM S IS
RDE TESTING UNDER EXTREME CONDITIONS
PERFORMANCE OF GAS PEMS IS

* HUMIDIFIED SPAN GAS (DEW POINT 51°C)
RDE TESTING IN ASIA

PEMS Test drive in India. Temperature > 45°C

Only our mobile phones did not work
HOW TO PERFORM A VALID RDE TEST?

4. VERIFICATION OF TRIP VALIDITY

4.1. Verification of \( v \cdot a_{\text{pos, \text{sys}}} \) per speed bin (with \( v \) in [km/h])

If \( \bar{v}_k \leq 74.6 \text{ km/h} \)
and
\[
(v \cdot a_{\text{pos}})_k[95] > (0.136 \cdot \bar{v}_k + 14.44)
\]
is fulfilled, the trip is invalid.

If \( \bar{v}_k > 74.6 \text{ km/h} \) and \( (v \cdot a_{\text{pos}})_k[95] > (0.0742 \cdot \bar{v}_k + 18.966) \) is fulfilled, the trip is invalid.

4.1.2. Verification of RPA per speed bin

If \( \bar{v}_k \leq 94.05 \text{ km/h} \) and \( \text{RPA}_k < (-0.0016 \cdot \bar{v}_k + 0.1755) \) is fulfilled, the trip is invalid.

If \( \bar{v}_k > 94.05 \text{ km/h} \) and \( \text{RPA}_k < 0.025 \) is fulfilled, the trip is invalid.

How can a driver make sure that all these conditions (and many more!) are fulfilled while he’s driving?

- Without being supported by a tool this is impossible!
- AVL provides an online tool which calculates and displays all relevant parameters for RDE compliant driving.
RDE TESTING UNDER REAL LIFE CONDITIONS
AVL M.O.V.E SYSTEM CONTROL EXTENSIONS

Online RDE Guidance

TRAFFIC
TOWN
RURAL
HIGHWAY
CONTENT

- Legislation: Updates Light Duty and Heavy Duty
- Test Execution: How to perform a valid RDE Test?
- **Test Evaluation: New Features in Concerto M.O.V.E**
- Development: RDE Cycles on a Chassis Dyno
- Development: RDE Cycles in the Engine Map
- Summary & Outlook
AVL CONCERTO M.O.V.E, BUILD 162

TUeV certified AVL M.O.V.E Post-Processor
for the newly released RDE regulation with the 2016/427, 2016/646 and amendment of the 2016/646 regulation.

- EMROAD and CLEAR evaluations
- Compliance of the RDE submission documents (data exchange and reporting) to the provision made in RDE package 1 - 2016/427 Appendix 8.
- Distinct “certification” workflow
The EU HD ISC 582/2011 has been updated by the release of 2016/1718 on 09/20/2016:

- 2011, 2017 and 2019 evaluations are available in Concerto M.O.V.E
- PN results for HD evaluations are available
- Map-based definition of “time marks” for urban, rural and city driving
- …
CONTENT

Legislation: Updates Light Duty and Heavy Duty

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Development: RDE Cycles on a Chassis Dyno

Development: RDE Cycles in the Engine Map

Summary & Outlook
EXECUTION OF RDE REFERENCE CYCLES

Mounting and Validation
Street Test
Data Transfer to Dyno

Re-Run on Dyno
Re-Run on Dyno

Speed <-> Road gradient

Road 2 Lab
Reportin
EXECUTION OF RDE REFERENCE CYCLES

Video!
CONTENT

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**Development:** RDE Cycles in the Engine Map

Summary & Outlook
IMPACT OF DRIVE CYCLES
IMPACT OF DRIVING STYLE

Impact of driving style in the AVL Graz RDE route on
- Drive dynamic
- Engine map
- Emissions

Dynamic Driving Style

Moderate Driving Style

• Vehicle Speed - km/h
• Torque - Nm
• Engine Speed - rpm

EU-6c Limit

- NOx
- PN

14 x
5 x
STATISTICAL ANALYSIS OF RDE DATA: NEW APPROACH
STATISTICAL ANALYSIS OF RDE DATA: NEW APPROACH – DIESEL NOX

„RDE weighted NOx map“:

• Height is proportional to statistical impact of engine map area on RDE NOx result.
• Differentiation between steady state and transient effects is possible → creation of „most relevant“ reference cycles
• Superposition – Tests for different variants (vehicle weight, gear box, ...) can be just „added up“ → multi variant calibration
RDE CONCERN AREAS GASOLINE ENGINES
Downsized Turbocharged GDI

Small SUV, downsized TGDI

 PN
 CO
 NOx
 Veh. Speed

Time - s

0 250 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000 3250 3500 3750 4000
STATISTICAL ANALYSIS OF RDE DATA: NEW APPROACH – GASOLINE NOX

Scavenging

RDE NOx Mass Weighted [g]

RDE Engine Map Speed [rpm]

Engine Load

Engine Speed

Critical Catalat Spere Velocity

Component Protection

Schematic
STATISTICAL ANALYSIS OF RDE DATA: NEW APPROACH – GASOLINE CO
CONCLUSION