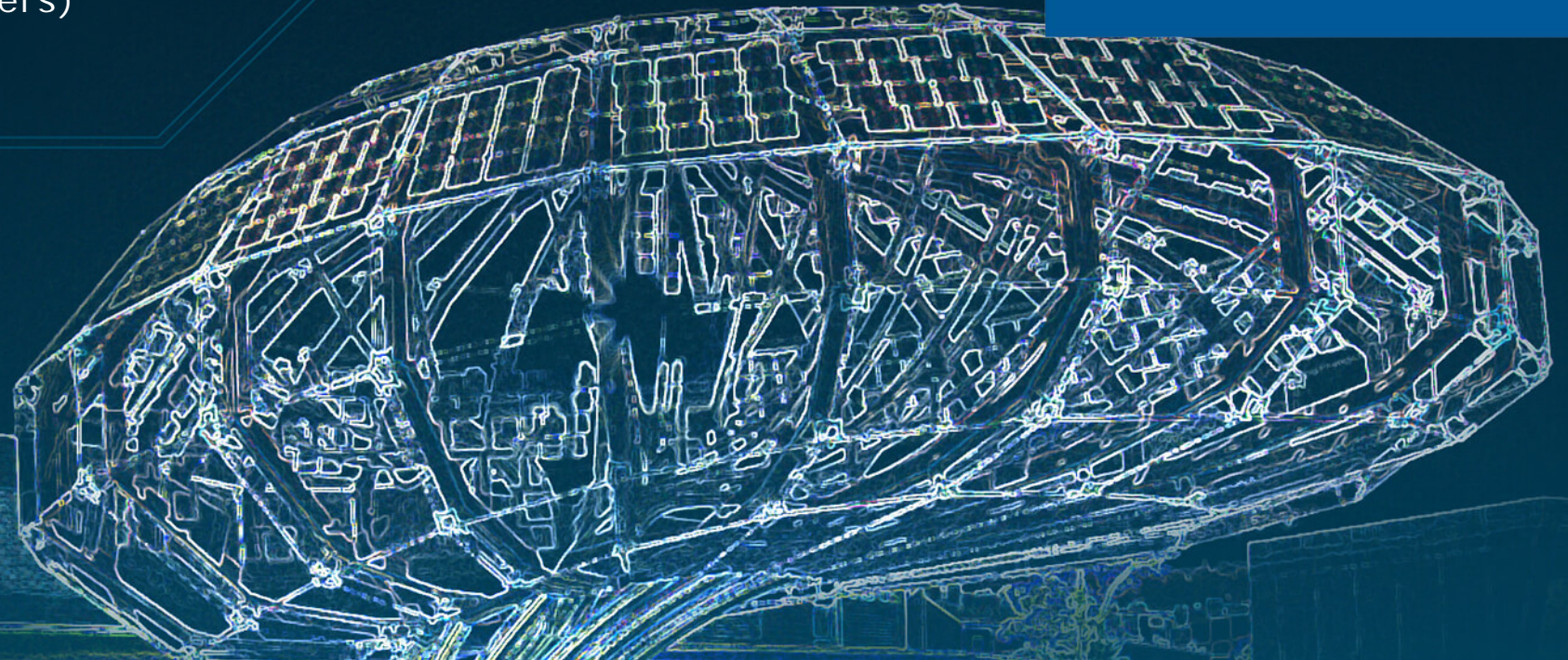


AVL List GmbH (Headquarters)



# Challenge „Real Driving Emissions“

PEMS Conference 2018 – Dr. Roland Wanker

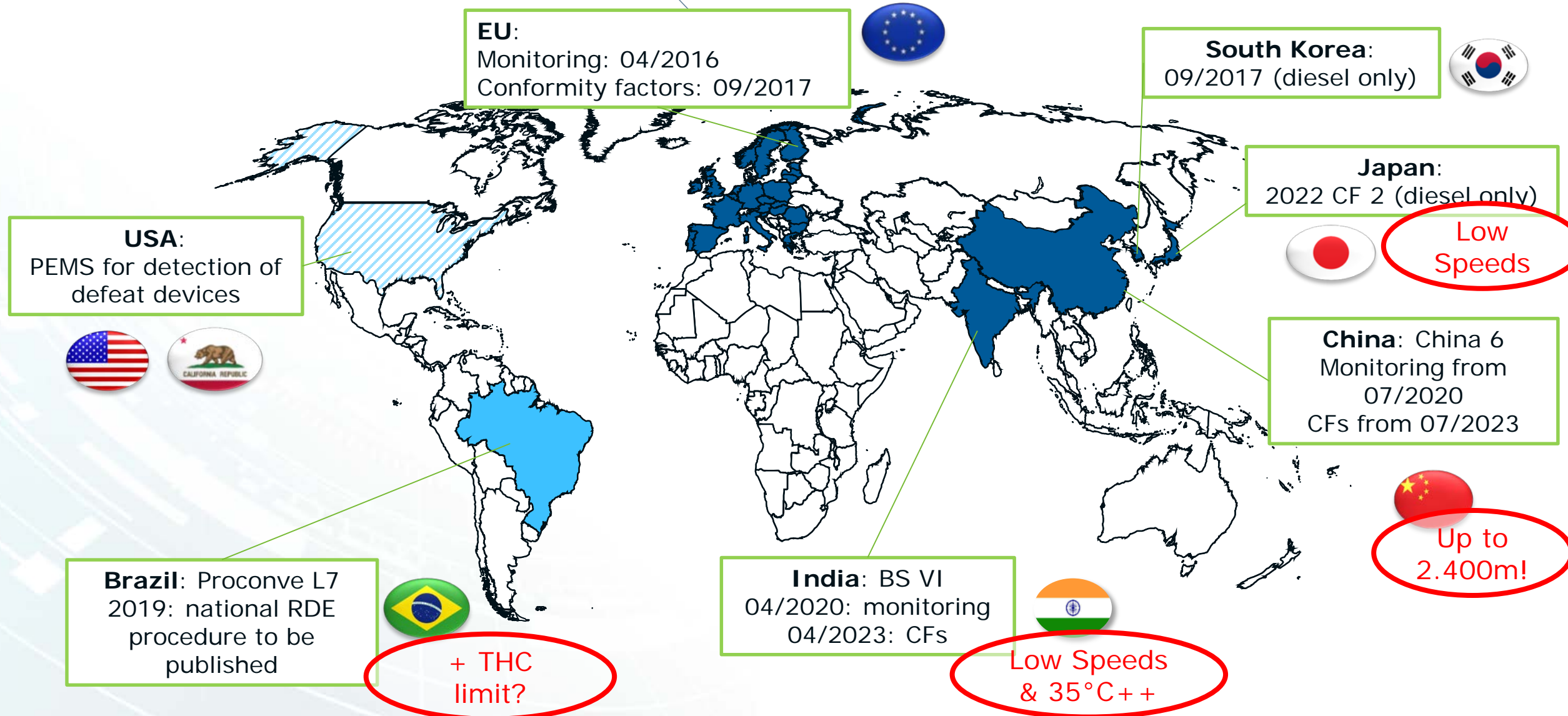


## RDE – A Challenge for ...

- The Authorities
- The PEMS Manufacturers
- The OEMs



## RDE IMPLEMENTATION WORLDWIDE





# RDE – A REAL challenge for the authorities



## TRAFFIC



## EXTREME CONDITIONS



## MOUNTAIN



## RANDOMNESS

Driving style has a strong impact on emission results.

## AMBIENT TEMPERATURE

Changing ambient temperatures can strongly impact the efficiency of exhaust aftertreatment systems.

## AMBIENT PRESSURE

Changing ambient pressure has strong impact on engine behavior, raw emissions, and exhaust aftertreatment systems.

## URBAN



## RURAL



## HIGHWAY





# RDE – A Challenge for the Authorities



- Challenge: Definitions needed!!!
  - What is “Real Driving” or “Normal Driving”?
  - What are normal operating conditions? High altitudes? Cold start?
  - What is an outlier? Statistics? What is a „Defeat Device“?
  - PEMS testing during initial type approval only? In Service Conformity? Third party testing? Member State Surveillance?
- Task:
  - Develop a set of regulations with involvement of several strong stakeholders.

# Speaking about „Normality“...

## Environmental Protection Agency

### § 1065.905 General provisions.

(a) *General.* Unless the standard-setting part specifies deviations from the provisions of this subpart, field testing and laboratory testing with PEMS must conform to the provisions of this subpart.

(b) *Field-testing scope.* Field testing conducted under this subpart may include any normal in-use operation of an engine.

... the NTE concept defines normality in the **engine** map

## Official Journal of the European Union

L 82

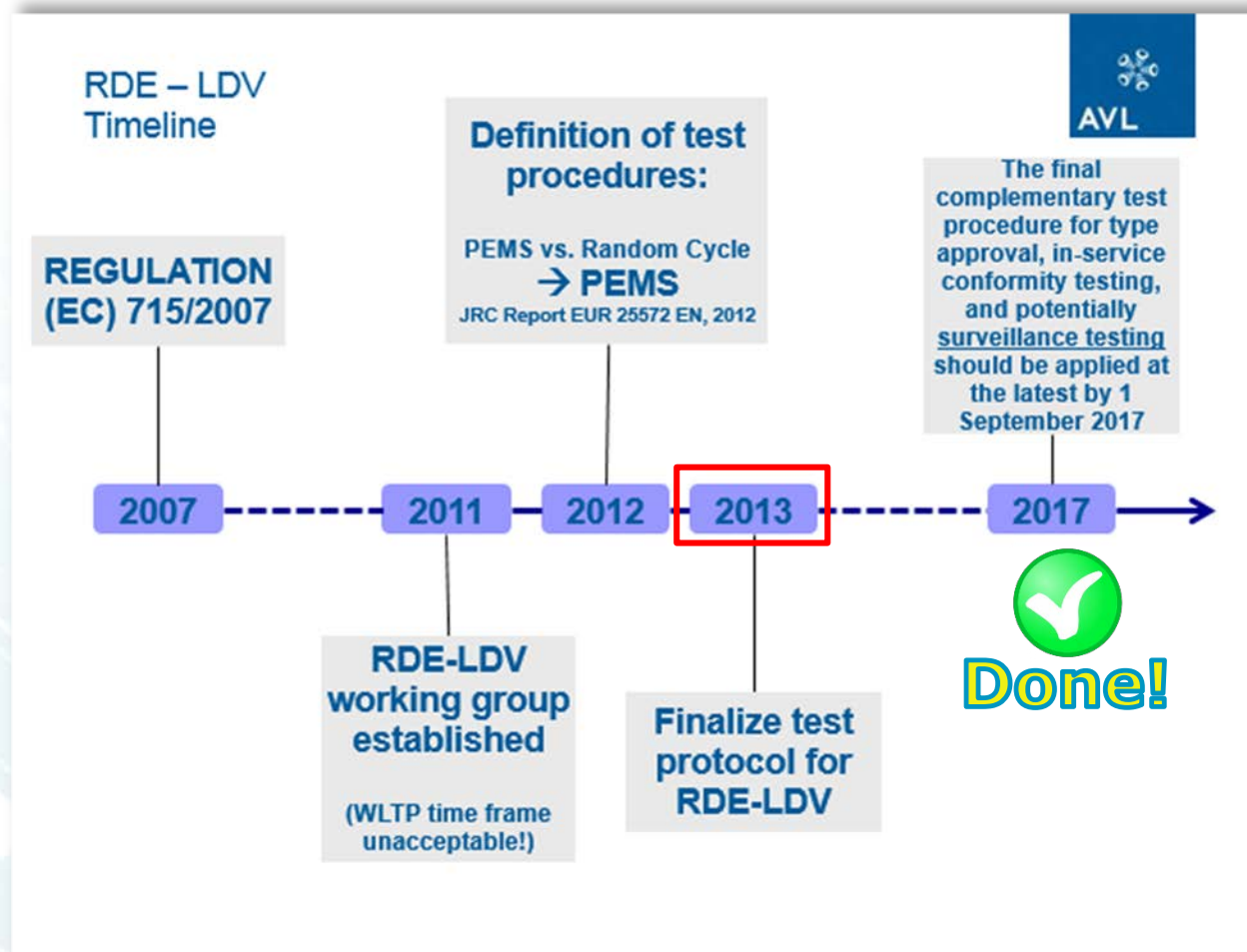


715/2007

In addition, the technical measures taken by the manufacturer must be such as to ensure that the tailpipe and evaporative emissions are effectively limited, pursuant to this Regulation, 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. Durability testing of pollution control devices undertaken for type approval shall cover 160 000 km. To comply with this durability test, the manufacturers should have the possibility to make use of test bench ageing, subject to the implementing measures referred to in paragraph 4.

... RDE for LD vehicles defines normality based on **vehicle** operation and dynamics

# Example: RDE in Europe



Slide shown by R. Wanker at the **CRC Conference, 2013**

- Step by Step Introduction:
  - Packages 1-3: Gas+PN Emissions at Type Approval
  - Package 4: In Service Conformity and Surveillance Testing (in work!)
- RDE Legislation...
  - 300+ pages
  - Amendments being released regularly...
- Work in Progress:
  - Procedure for qualification of PEMS systems under all environmental conditions.
  - Annual review of conformity factors.
  - ...



# RDE – A REAL challenge for on road emissions testing



## TRAFFIC



## EXTREME CONDITIONS



## MOUNTAIN



## RANDOMNESS

Driving style has a strong impact on the equipment – shocks and vibrations.

## AMBIENT TEMPERATURE

Changing ambient temperatures can strongly impact the quality of RDE test data.

## AMBIENT PRESSURE

Changing ambient pressure is the key decision criterion for the selection of PEMS analyzers..

## URBAN



## RURAL



## HIGHWAY





# What is a PEMS?

## What is required by legislation?



### A PEMS needs to measure:

- Ambient Conditions (Temperature, Humidity, Pressure)
- GPS Position (Latitude, Longitude, Altitude)
- OBD / CAN Bus Data (Vehicle Speed, RPM, ...)
- Exhaust Mass Flow
- Gaseous Emissions (NO<sub>x</sub>, CO, CO<sub>2</sub>)
- PN/PM Emissions

#### Subpart J—FIELD TESTING AND PORTABLE EMISSION MEASUREMENT SYSTEMS

§1065.901	Applicability.
§1065.905	General provisions.
§1065.910	PEMS auxiliary equipment for field testing.
§1065.915	PEMS instruments.
§1065.920	PEMS calibrations and verifications.
§1065.925	PEMS preparation for field testing.
§1065.930	Engine starting, restarting, and shutdown.
§1065.935	Emission test sequence for field testing.
§1065.940	Emission calculations.

2

ie 59  
2016

#### REGULATIONS

★ Commission Regulation (EU) 2016/427 of 10 March 2016 amending Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6)(<sup>1</sup>) 1

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### Legislation defines under **Lab Conditions**:

- Requirements on the performance (accuracy, noise, repeatability, linearity, ...) for every single data channel
- Measurement principles (NDIR, CLD, NDUV, ...)
- Rise Time/Data rate
- Zero & Span response drift
- Chiller penetration
- Cross sensitivities
- Overall system verification (1065 Subpart J)
- Chassis Dyno verification (RDE)
- ...



# What is a PEMS?

## What is required by legislation?

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### Legislation defines under **Real World Driving**:

- Cyclic Zero Checks (US HDIUT only)
- Pre&Post Test: Zero & Span response drift

- No quality criterion on span/audit during the test at all!
- Can the 0.2g/bhphr NO<sub>x</sub> be ensured by this?
- Is this sufficient as a concept for traceable 0.02g/bhphr NO<sub>x</sub> limit?

# RDE –

A REAL challenge for on road emissions testing



TRAFFIC

EXTREME CONDITIONS

MOUNTAIN

This is where the challenge comes from!

- Measurement principles – *not all suitable under changing ambient conditions*
- Sample conditioning – *as important as the analyzer, not checked at all*
- Measurement of velocity/distance – *direct impact on g/mi limit...*
- Measurement of engine power – *direct impact on g/bhphr limit...*
- .....

URBAN

RURAL

HIGHWAY



# RDE – A REAL challenge for vehicle development



## TRAFFIC



## EXTREME CONDITIONS



## MOUNTAIN



## RANDOMNESS

Driving style has a strong impact on emission results.

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Changing ambient temperatures can strongly impact the efficiency of exhaust aftertreatment systems.

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## URBAN



## RURAL



## HIGHWAY





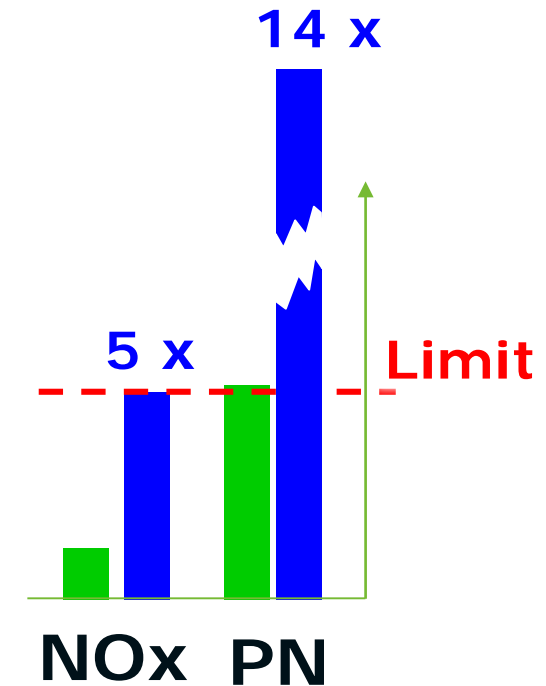
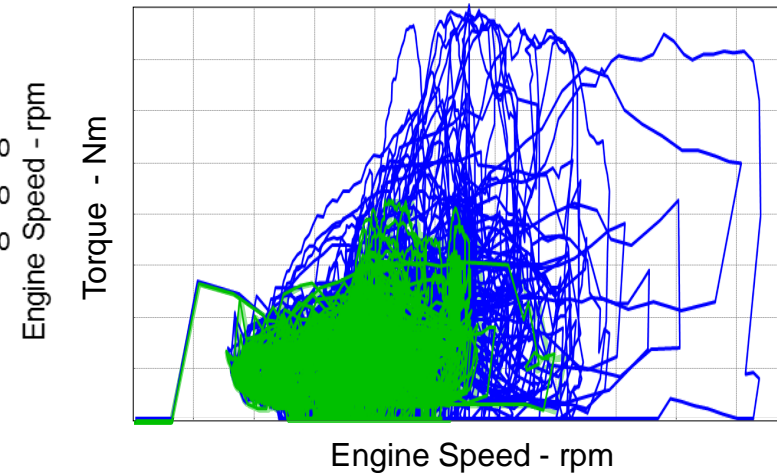
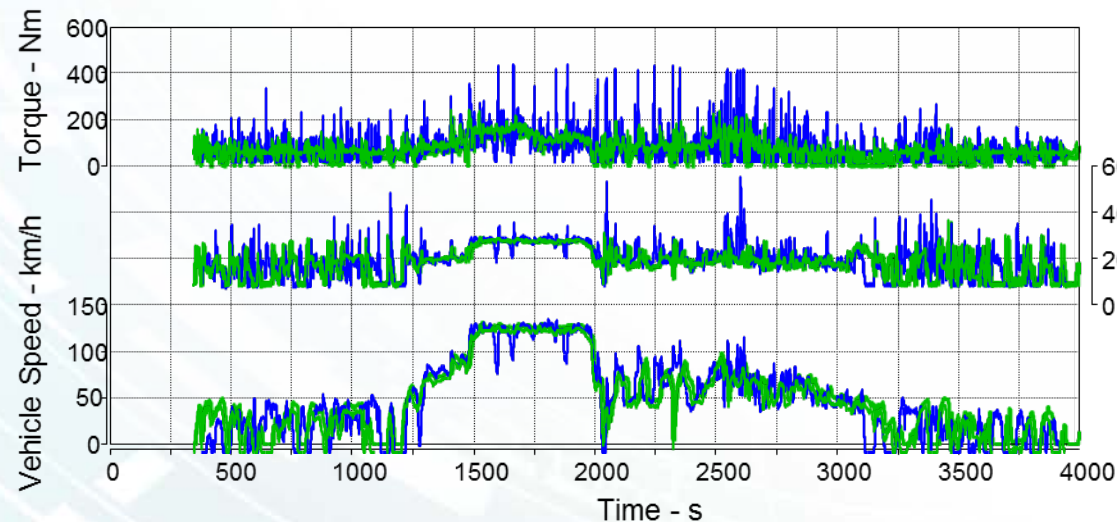
## Impact of driving style



Impact of driving style in the AVL Graz RDE route on

- Drive dynamic
- Engine map
- Emissions

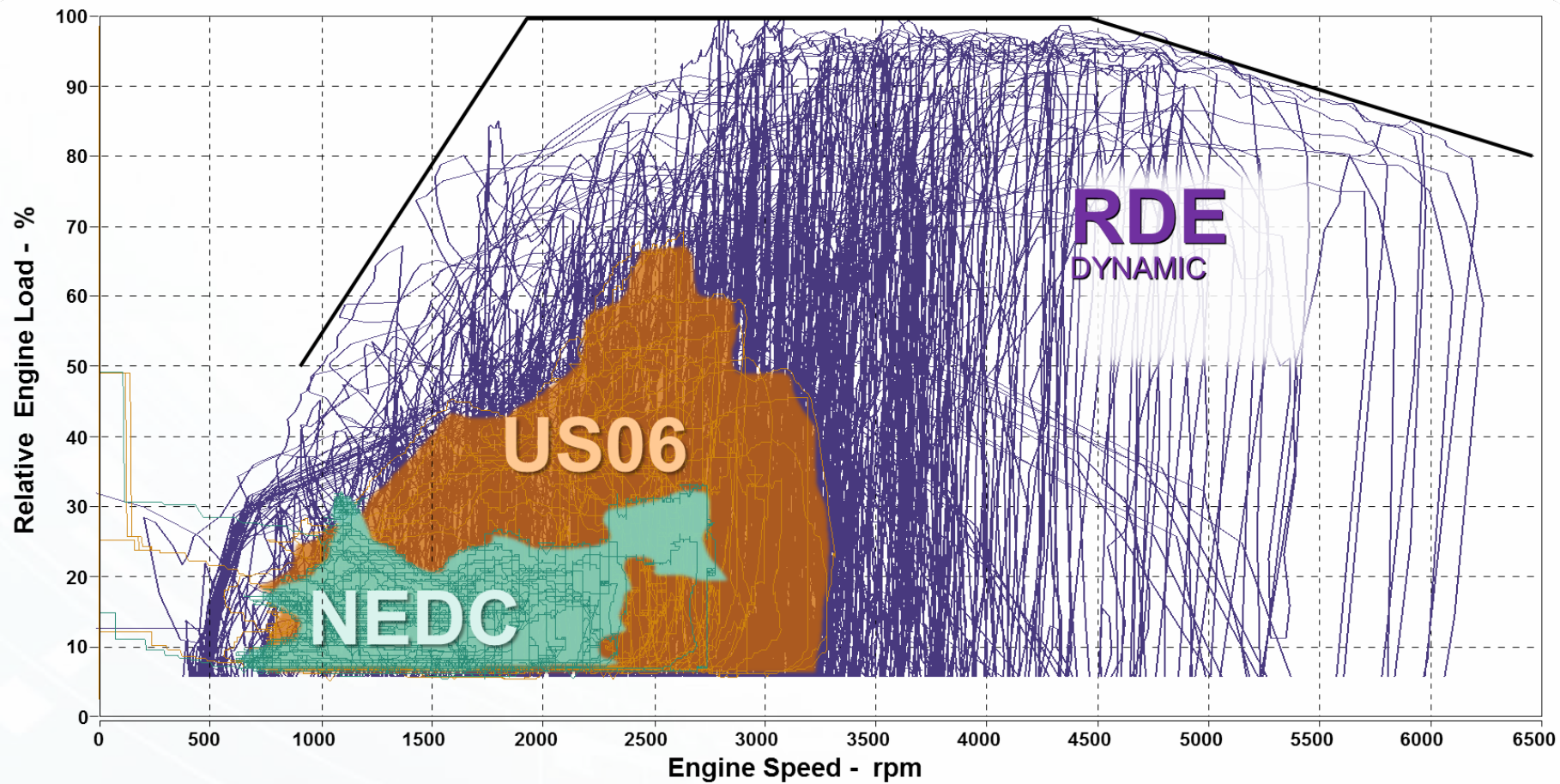
### Dynamic Driving Style



### Moderate Driving Style



# Impact of drive cycles

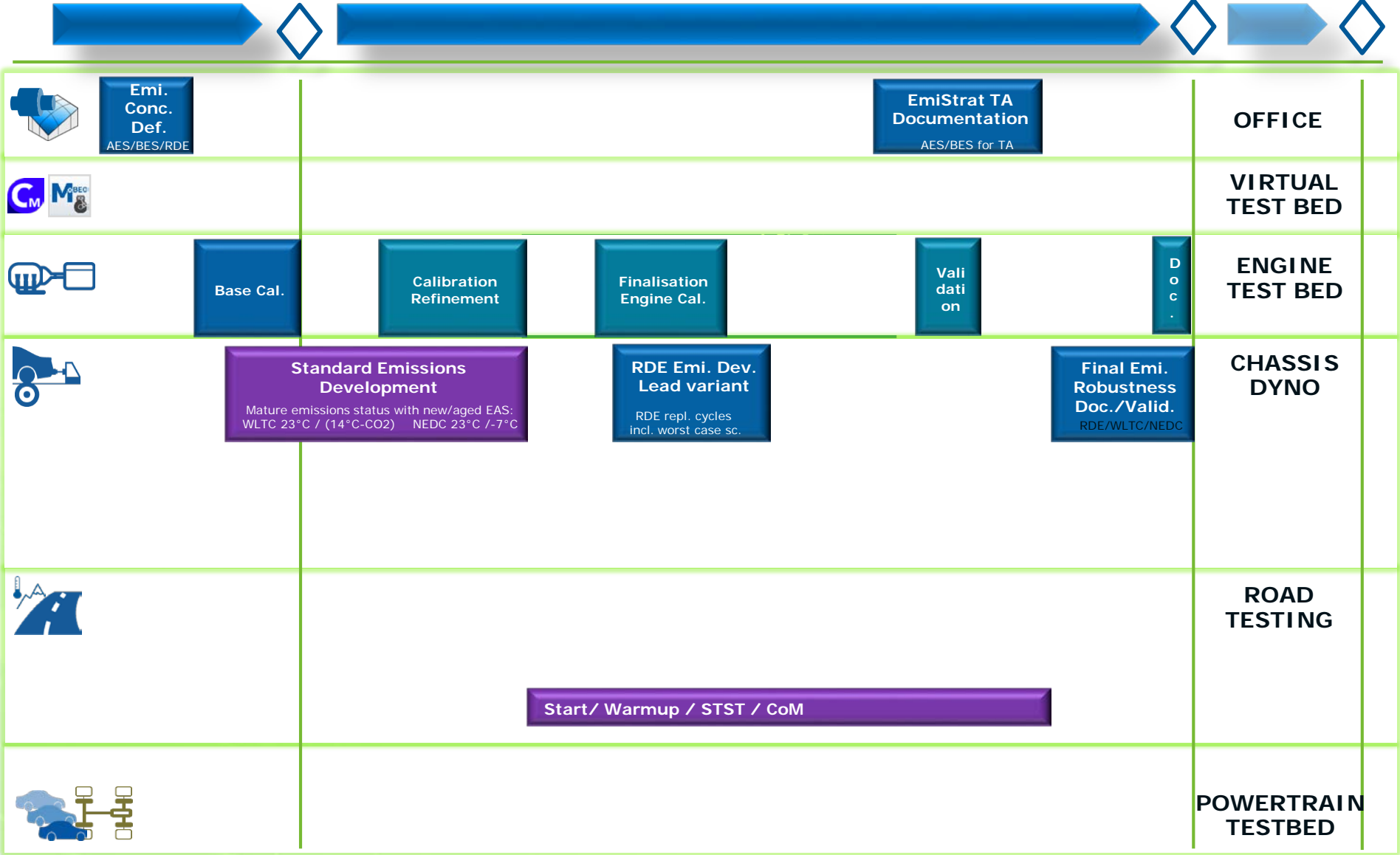


# AVL Emission Development and Calibration Process

1<sup>st</sup> VEH. cal

w/o RDE

SOP



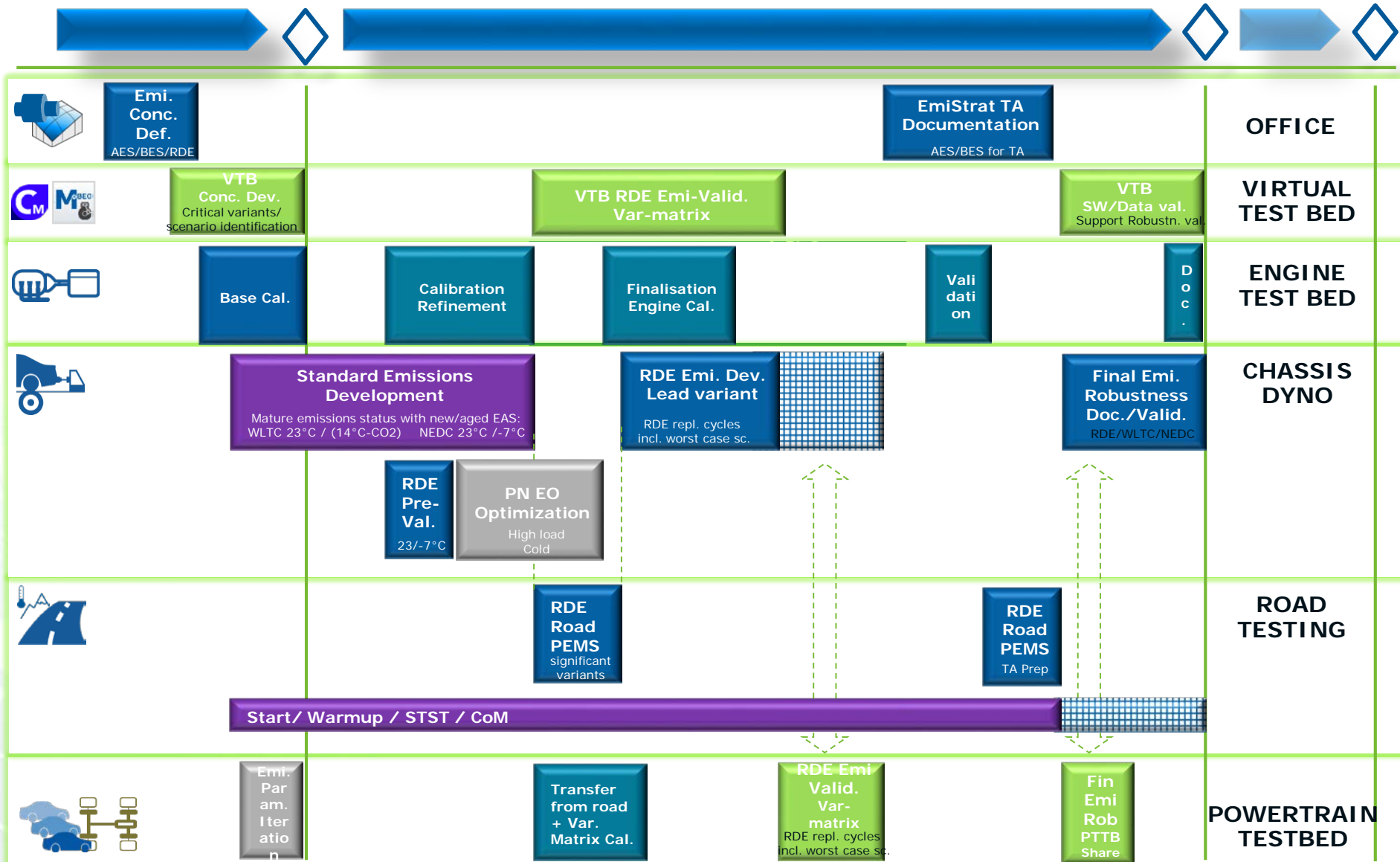


# AVL Emission Development and Calibration Process

with RDE

1<sup>st</sup> VEH. cal

SOP



# RDE – A REAL challenge for vehicle development



TRAFFIC

EXTREME CONDITIONS

MOUNTAIN

## RDE is a game changer for passenger car development!

- Development efforts – *strongly increasing*
- Development process – *to be re-designed and implemented*
- Infrastructure – *to be updated and extended*
- Skills – *to be developed*
- A clear set of regulations is required!

URBAN

RURAL

HIGHWAY



RDE is us!  
Visit us at CE-CERT!

