

New results from a 2015 PEMS testing campaign on a Diesel Euro 6b vehicle

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Association for Emissions Control by Catalyst AISBL



Association for Emissions Control by Catalyst (AECC) AISBL

AECC members: European Emissions Control companies



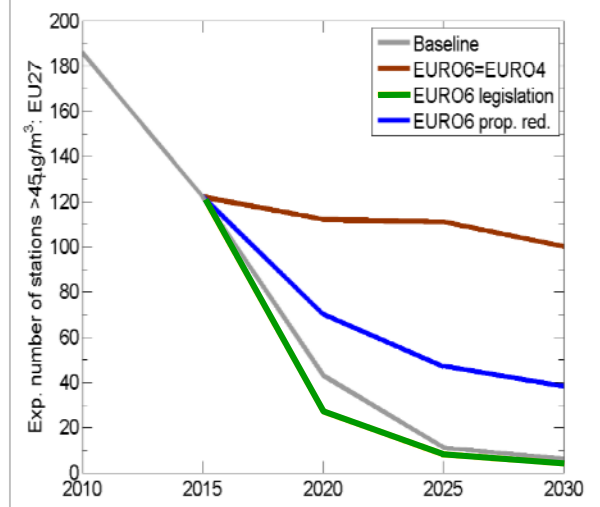
Exhaust emissions control technologies for original equipment, retrofit and aftermarket for all new cars, commercial vehicles, motorcycles and non-road mobile machinery.



Diesel NOx and air quality

- The 2007 Euro 6 Regulation (EC 715/2007) requires emissions to be effectively limited throughout the normal life of the vehicles under normal conditions of use.
 - Control of Diesel NOx in real-world driving conditions is an essential step towards EU Member States meeting air quality targets.
- Emissions inventory and projections by DG Environment for different NOx Conformity Factors:
 - Baseline CF=1.5
 - Euro 6 does not reduce real-world NO₂ further compared with Euro 4 (CF~10)
 - Euro 6 NOx RDE reduce proportionally (CF=4)
 - CF=1, Euro 6 limits met in real-world
 - With a CF~4, NO₂ non-compliance in 2020 is 3 times higher than in the baseline (CF=1.5) scenario (“stations substantially above the NO₂ limit would increase from 3 to 10%”).

Figure 8: Baseline projected compliance with NO₂ standards in case Euro 6 would not correct the real world emission problems



Source: European Commission Staff Working Document – Impact Assessment accompanying the Clean Air Package, SWD(2013)531, 18 December 2013.

Context of AECC test programme

- AECC recently demonstrated^[1] NOx Deviation Ratios between 1.1 and 1.6 on a development vehicle, under specific boundary conditions, and with advanced calibration of existing Euro 6 Diesel emissions control technology.
- Emissions Analytics identified some Euro 6 cars with low on-road NOx emissions. AECC decided to evaluate one of them, according to the EU RDE procedure.
- AECC investigated at Ricardo, UK the real-world emissions performance of a commercially available Euro 6 Diesel car equipped with an advanced emissions control system.

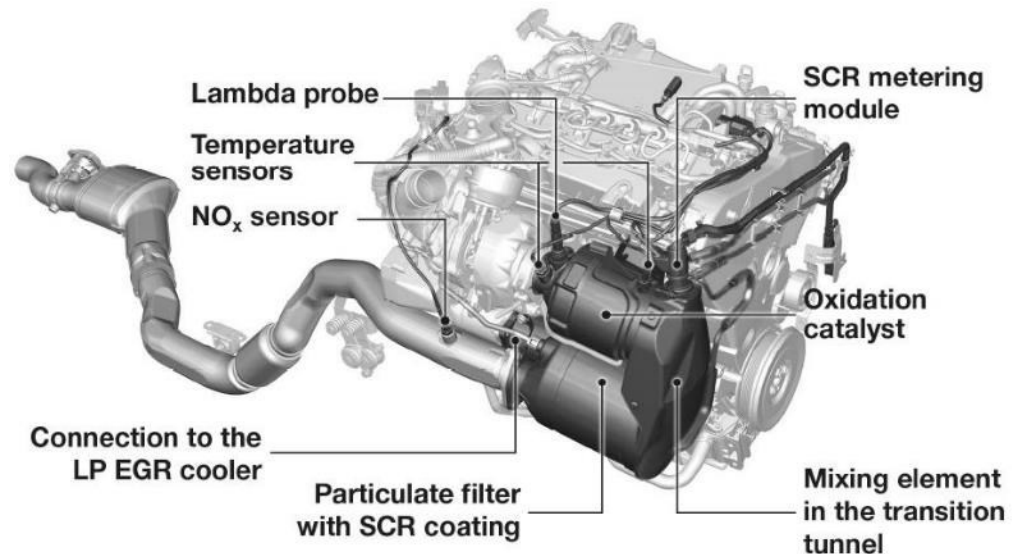
[1] "Potential for Euro 6 Passenger Cars with SCR to meet RDE Requirements", 36th International Vienna Motor Symposium, May 2015, www.aecc.eu/content/pdf/150507%20FEV-AECC%20paper%20Potential%20for%20Euro%206%20Passenger%20Cars%20with%20SCR%20to%20meet%20RDE.pdf.

Test vehicle

- 2.0l Euro 6b Diesel car, 120 kW
- Emission Control System: Close Coupled DOC + SCR on DPF, High and Low Pressure EGR
- Vehicle and exhaust ageing ~5800 km
- Pump grade EN590 Diesel fuel (~9 ppm S, 2.6% FAME)

	Emissions
CO ₂	111 g/km
CO	203.4 mg/km
NO _x	56.4 mg/km
THC+NO _x	82.4 mg/km
PM	0.15 mg/km
PN	2 x 10 ⁹ /km

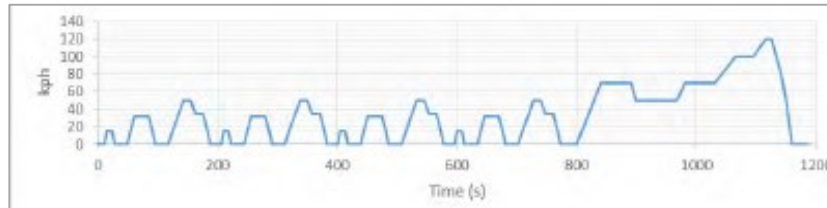
Source: CoC



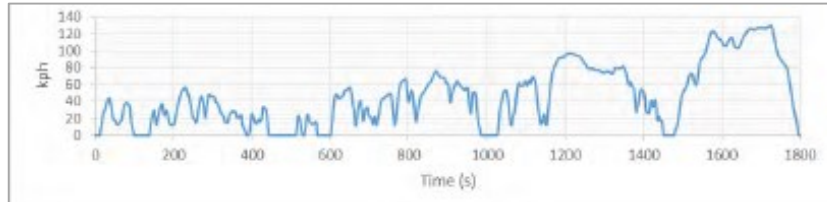
Source: Lörch, Aachen Colloquium 2013

Emissions test regime

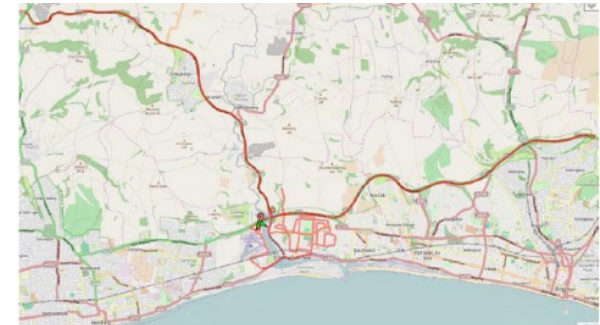
- NEDC



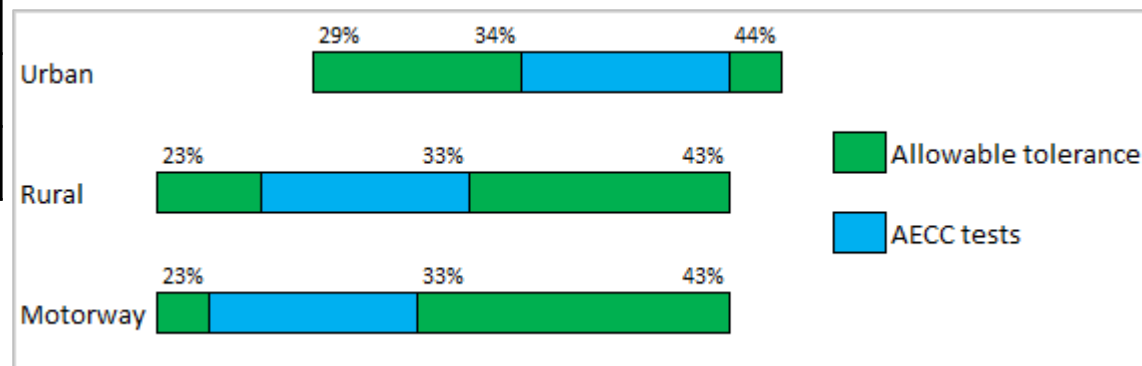
- WLTC



- Real-Driving Emissions (RDE) route around Ricardo Technical Centre

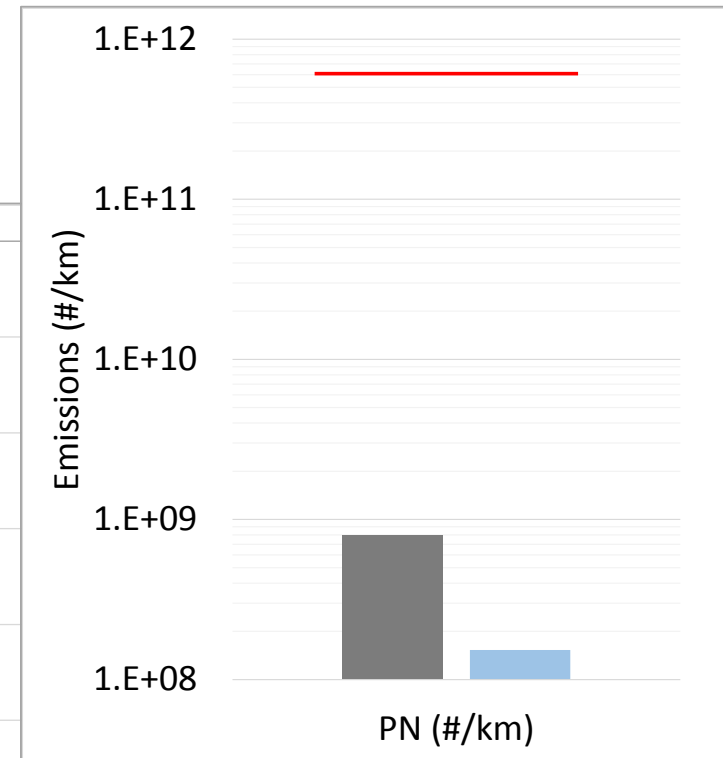
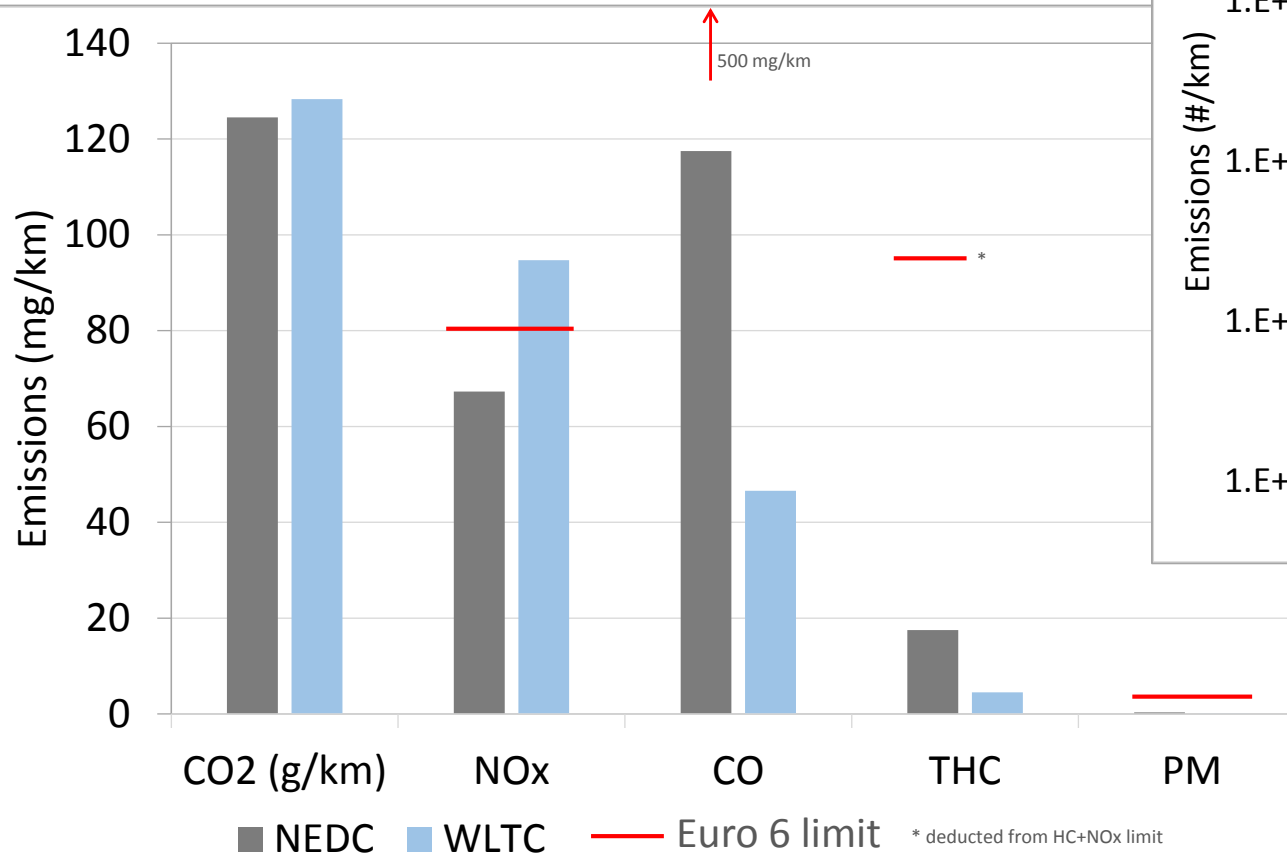


Duration	103 to 112 min
Ambient temperature	8 to 29°C
Altitude	-8 to 130 m
Max. speed	121 to 130 km/h



Tailpipe emissions on NEDC and WLTC

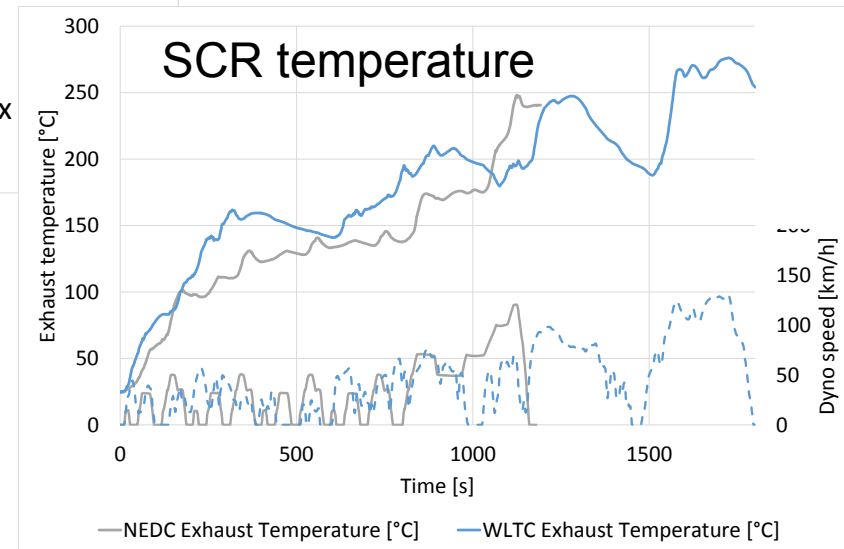
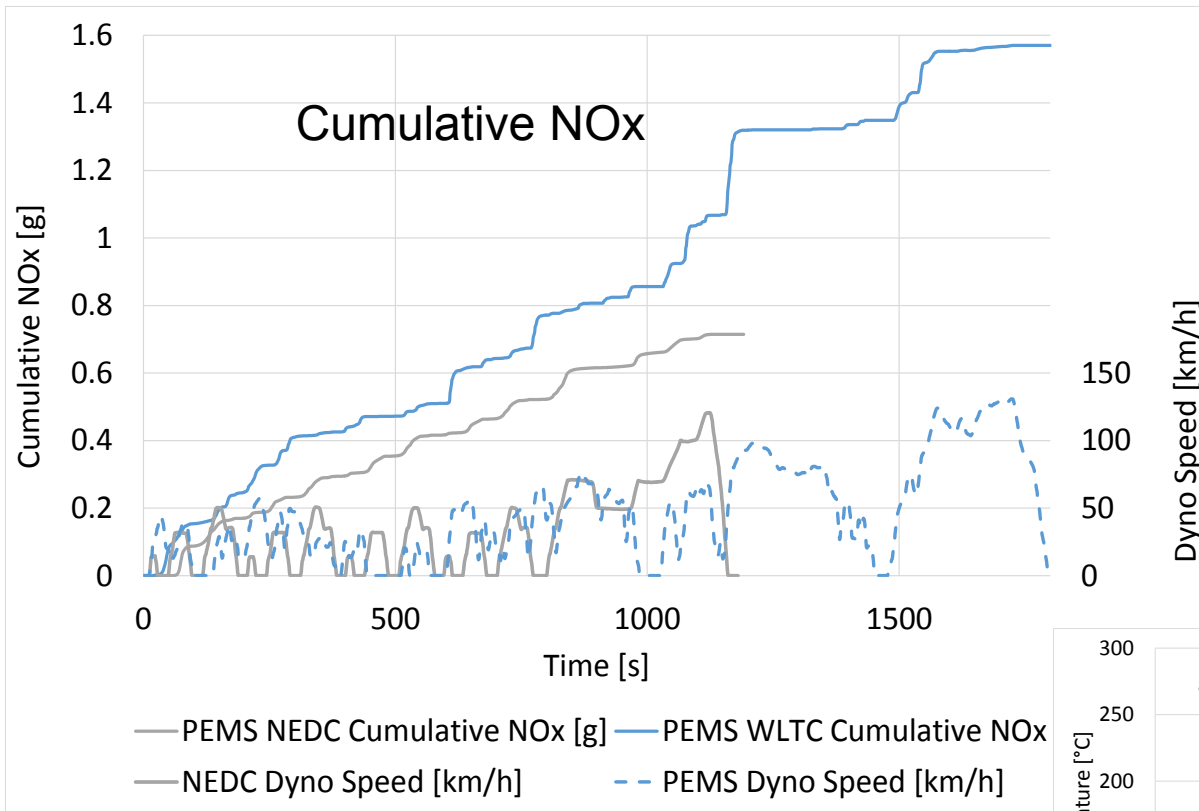
- Euro 6 limits met for all pollutants, except NOx on WLTP.



Vehicle inertia

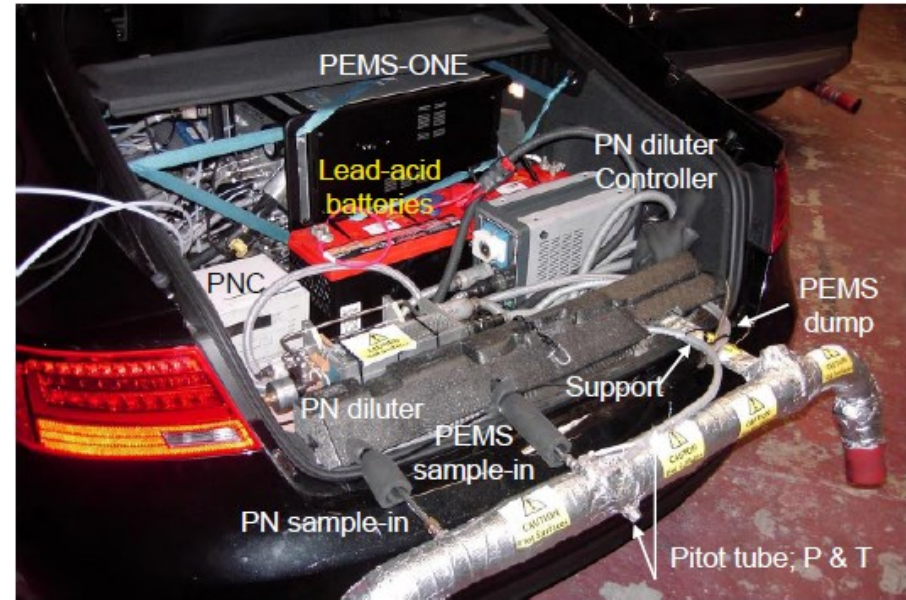
- NEDC: 1590 kg
- WLTC: 1680 kg

Tailpipe NOx emissions on test cycles



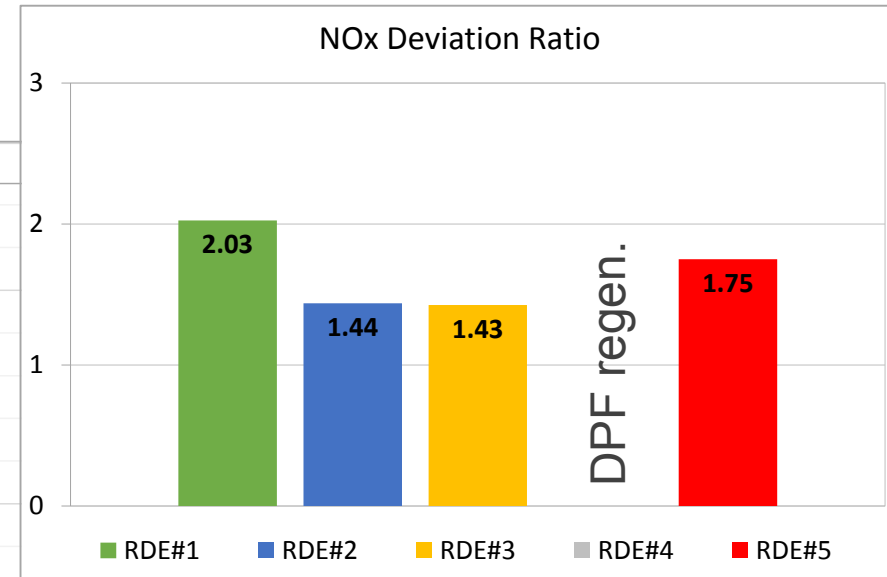
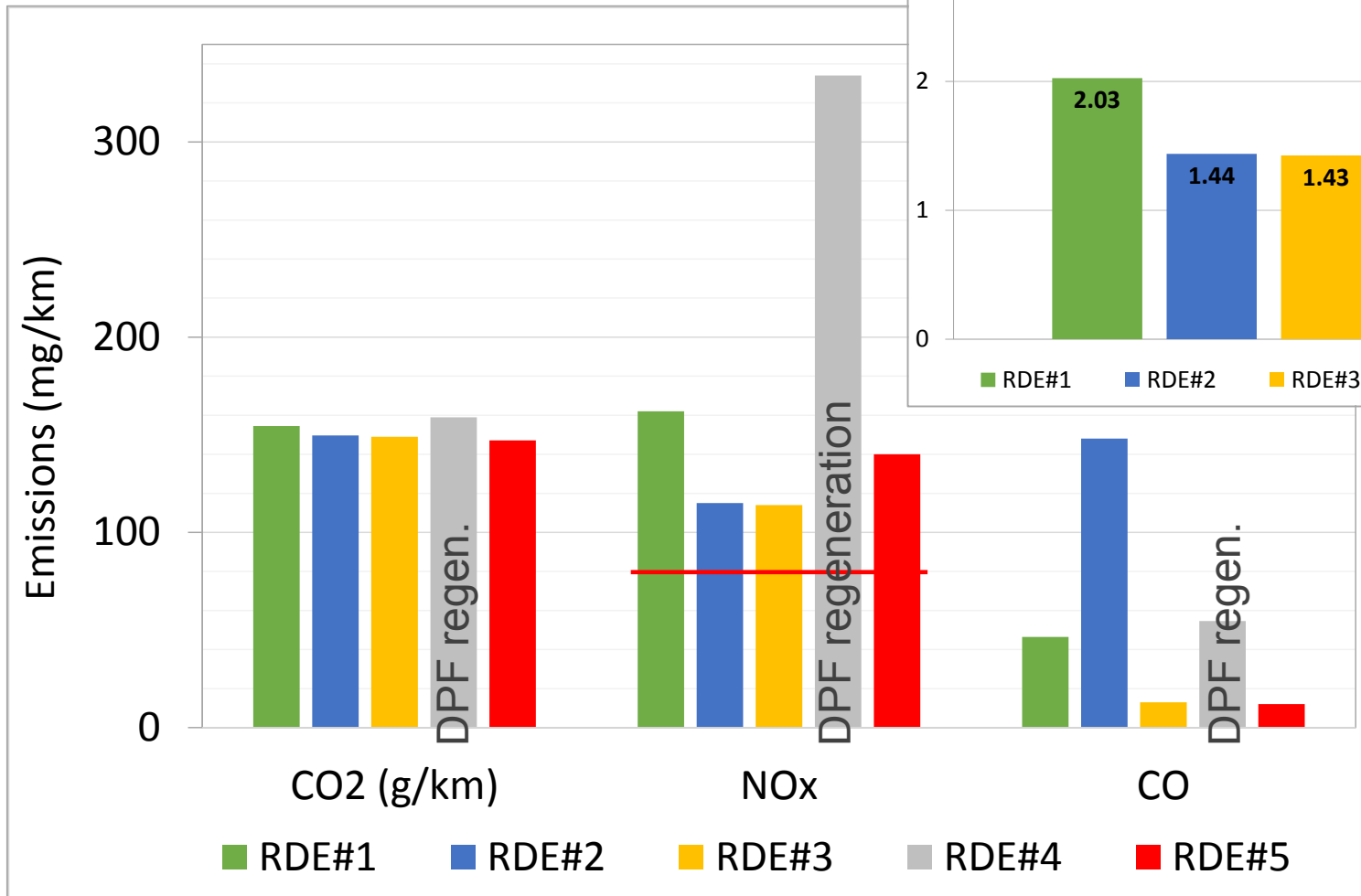
Portable Emissions Measurement System (PEMS)

- Horiba PEMS ONE for gaseous emissions (CO, CO₂, NO, and NO_x).
- Matter Engineering MD19-2E hot diluter with TSI 3010 particle number counter modified to provide a ~23 nm counting efficiency (d_{50}) comparable to lab-based PMP for particle number.



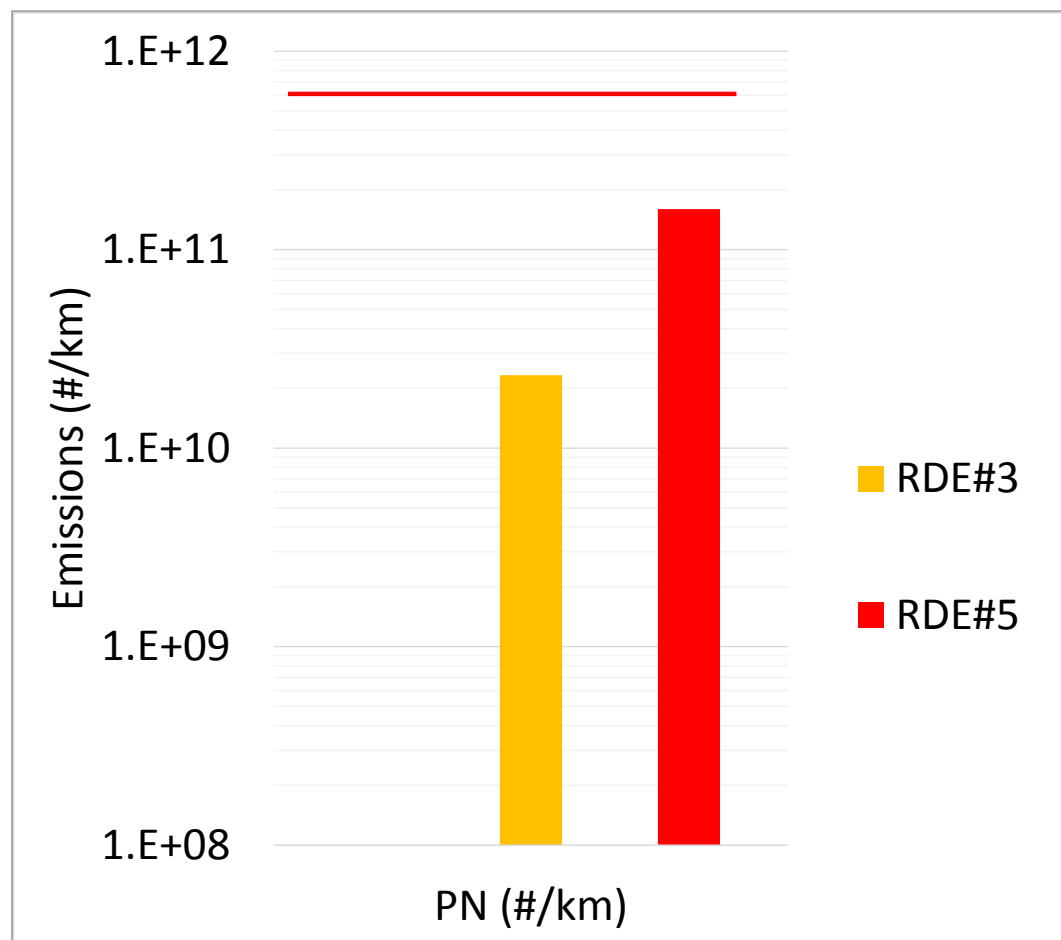
Real-Driving Emissions

- 5 repeats of same RDE route.

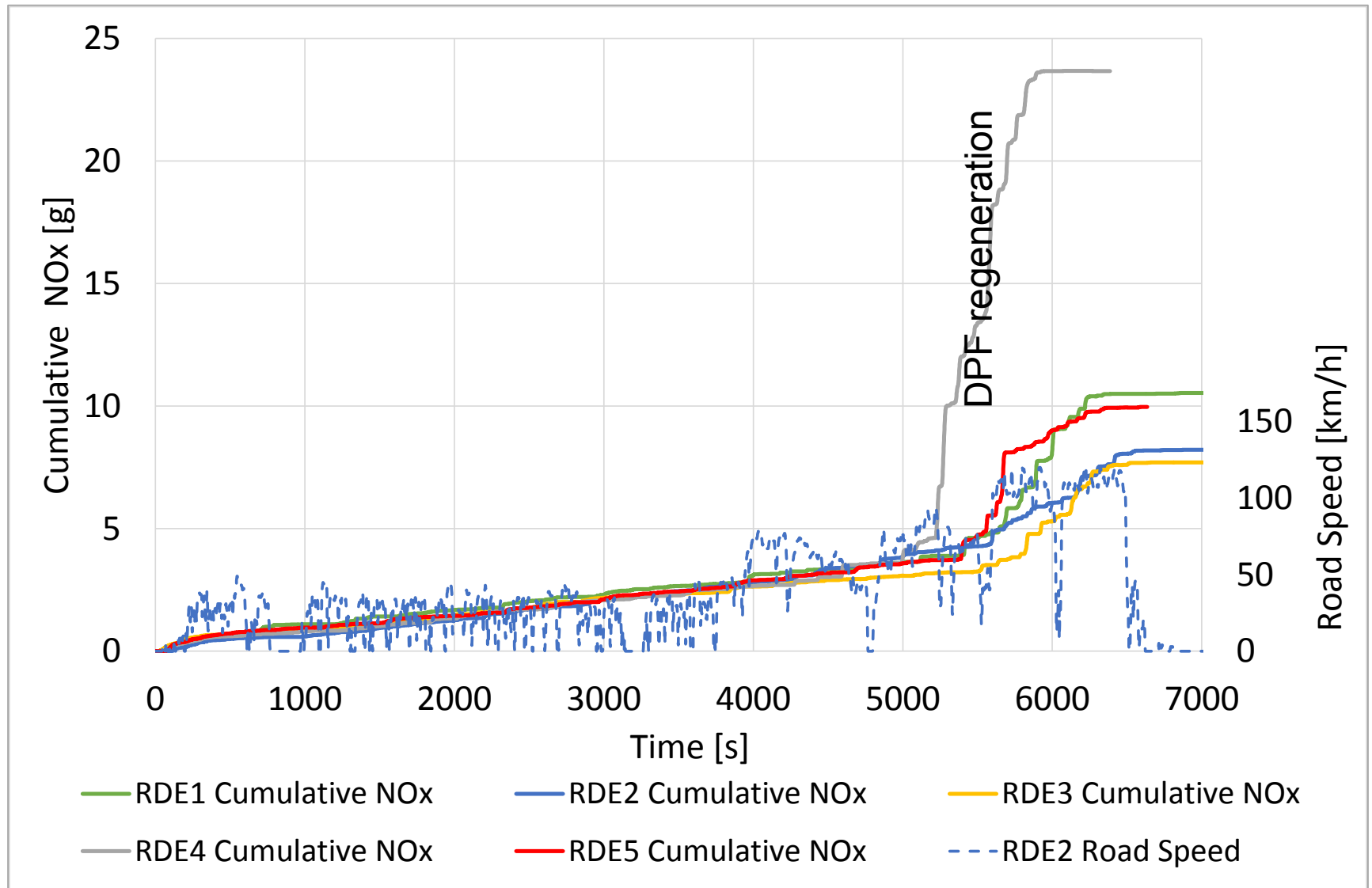


Particle Number is controlled under real-world conditions

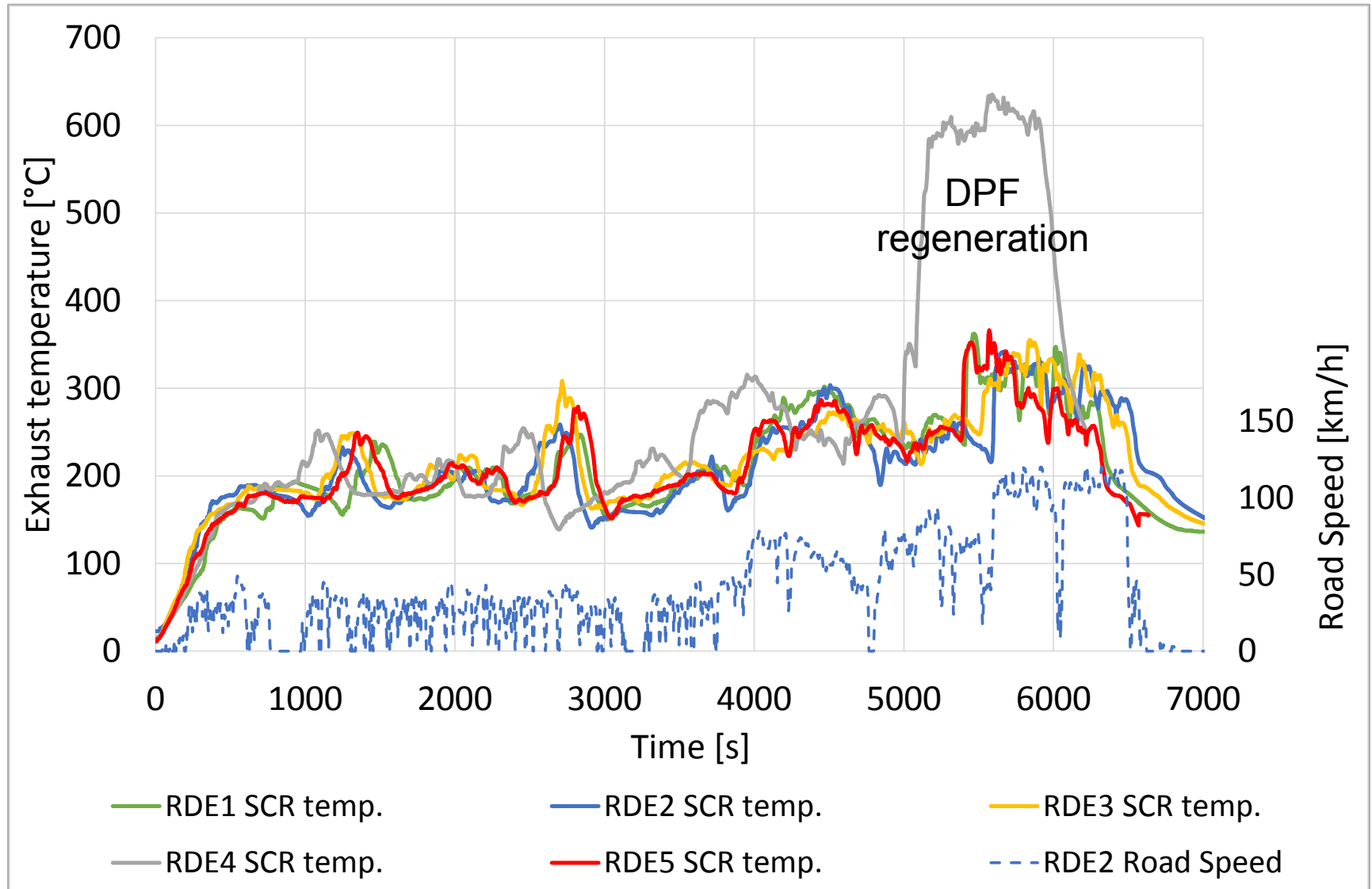
- Power supply issue on RDE#1, 2, and 4.
- PEMS PN available only for RDE#3 and RDE#5.



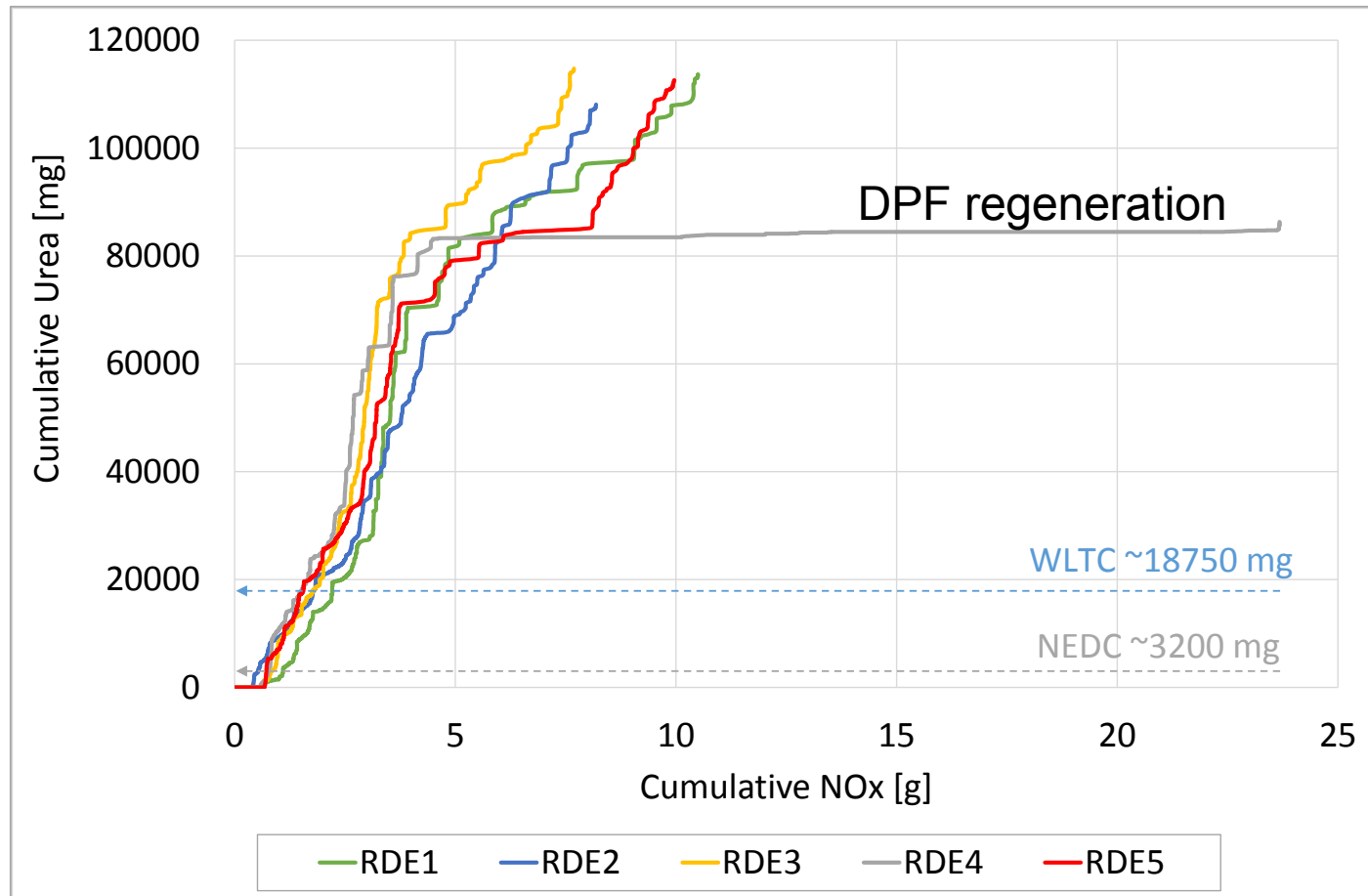
On-road NOx emissions



On-road SCR temperature



Urea dosing and tailpipe NOx emissions



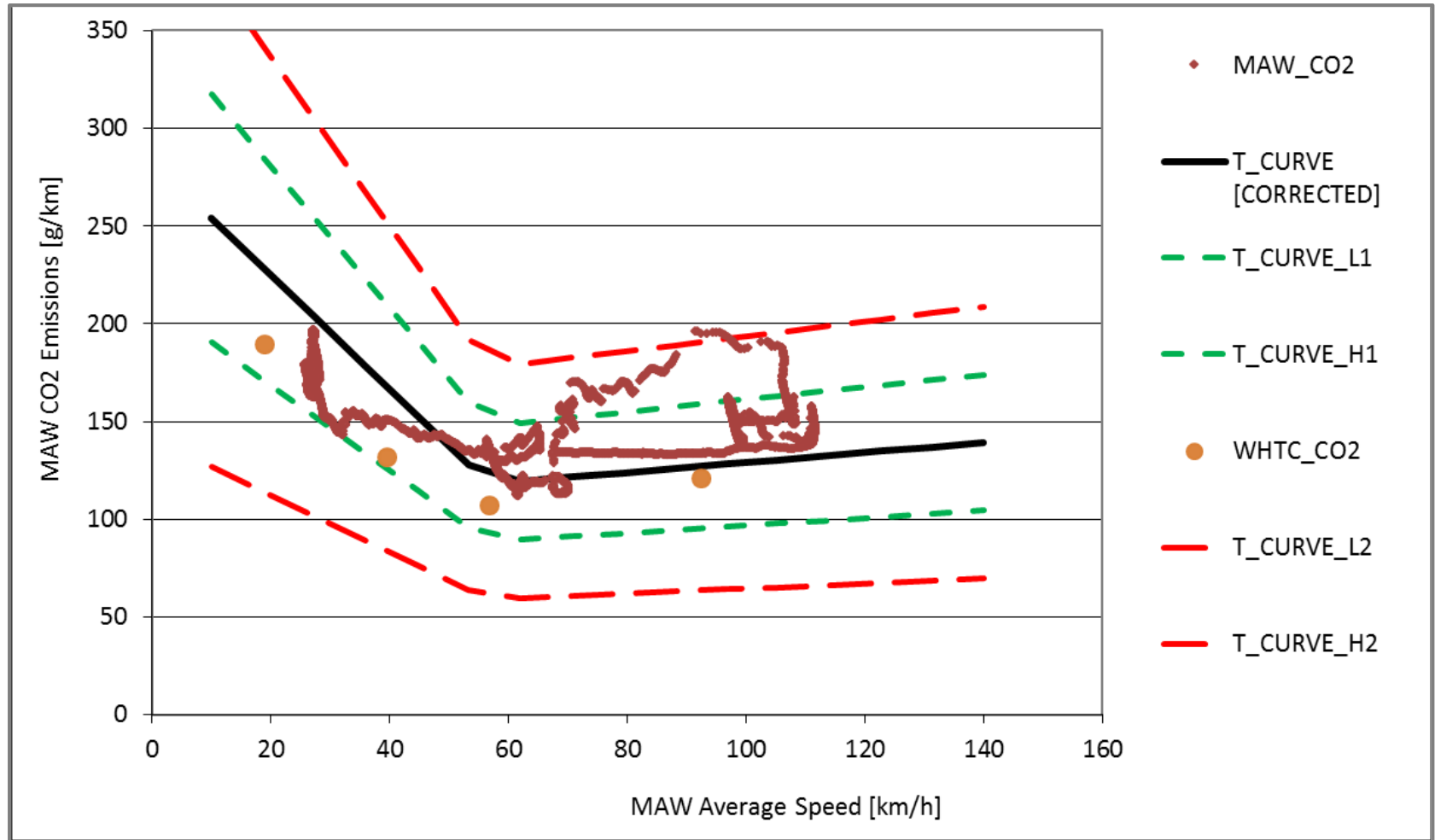
- Urea dosing on RDE tests: 1.31 l/1000km
- Tank size: 17.1 l → AdBlue® refill interval: 13000 km

PEMS data analysis with EMROAD

Test	Route validity				Emissions		EMROAD processing				
	Duration (min)	% Distance by phase			CO ₂	NOx	Valid MAW >15%			EMROAD driving style	NOx DR
		Urban <60kph	Rural	Mway >90kph	(g/km)	(mg/km)	Urban <60kph	Rural	Mway >90kph	≥50% valid MAW “normal” in each phase	
RDE#1	111	39%	30%	31%	154.5	162	55%	32%	13%	yes	2.03
RDE#2	110	42%	26%	32%	149.7	115	52%	32%	16%	yes	1.44
RDE#3	115	42%	33%	25%	148.9	114	54%	34%	12%	yes	1.43
RDE#5	115	37%	33%	30%	147.1	140	57%	30%	13%	yes	1.75

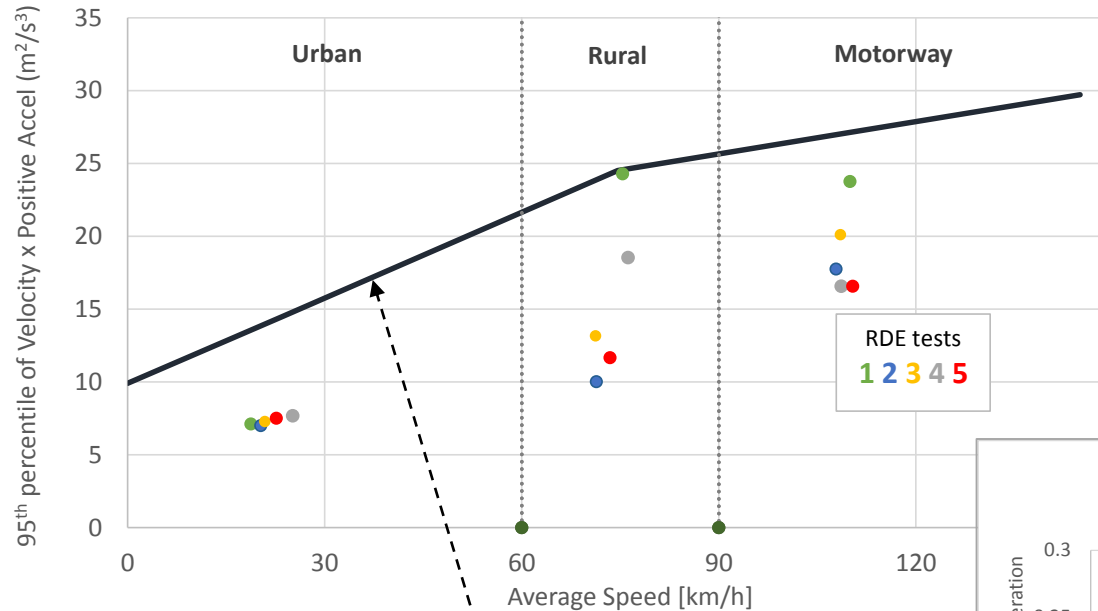
- Only RDE#2 is fully valid, including share of Moving Average Windows in Motorway conditions > 15%.
- RDE#2 achieves a NOx Deviation Ratio of 1.44 when calculated by EMROAD (vs. 1.2 based on unprocessed on-road emissions).

EMROAD Post-processing – RDE#2



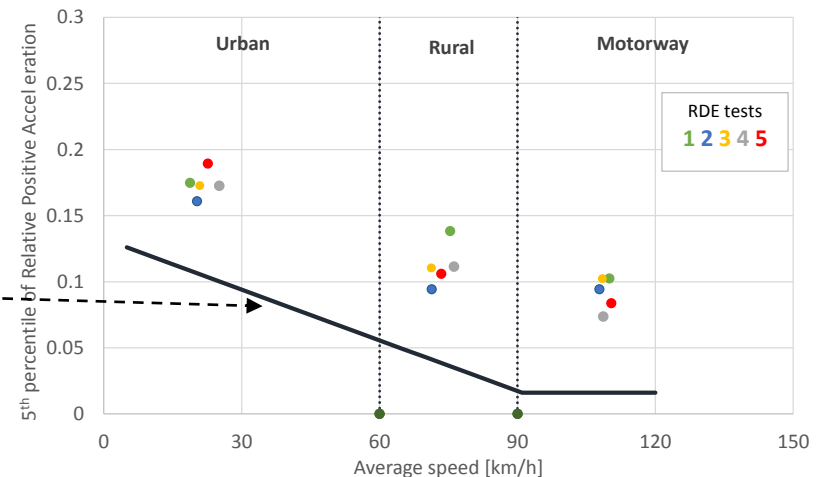
Dynamic characteristics of RDE trips

RDE Cycle Aggressiveness Check
(Velocity x Positive Acceleration)



Currently proposed thresholds

RDE RPA (Relative Positive Acceleration) Check




Conclusions

- Challenges were encountered to obtain a valid test with EMROAD.
- A commercially available Euro 6b Diesel car using an advanced emissions control system showed a NO_x Deviation Ratio of 1.44 when tested under specific boundary conditions and according to current RDE procedure (incl. data post-processing).
- This was achieved with a urea consumption of 1.31 l/1000km, corresponding to a 13000 km refill interval, requiring customer intervention.


Acknowledgments

- Thanks to Ricardo for their expertise in conducting repeatable testing, providing robust results and analysing the data in a timely manner.

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Who are AECC and what do we do ?

AECC is an international non-profit scientific association of European companies making technologies for engine exhaust emissions control.

The members of AECC are companies operating worldwide in the research, development, testing and manufacture of key technologies for emissions control.

Their products are the ceramic and metallic substrates for catalysts and filters; autocatalysts (substrates with catalytic materials incorporated or coated); adsorbers; filter-based technologies to control particulate emissions from diesel and other lean burn engines; and speciality materials incorporated into the catalytic converter or filter.


Catalyst-equipped cars were first introduced in the USA in 1974 but only appeared on European roads in 1985 and in 1993 legislation forced their use on cars. Now more than 275 million of the world's 500 million cars and over 85% of all new cars produced worldwide are equipped with autocatalysts. Catalytic

What are the emission control technologies?


Exhaust gas contains carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). The main technologies used to treat exhaust to remove harmful gases and particles are:

- autocatalysts
- adsorbers (traps)
- filters

There are more details on the technology pages.



Thank you for your attention



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