VERT: Filter Testing and further efforts to minimize emissions

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VERT Forum, EMPA, 15.03.2018

CONTENTS

- VERT DPF certification – learned lessons
- VERTdePN & TeVeNO_x
- PN@RDE → GPF
- NPTI
- VERTdeNO_x for passenger cars

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VERT DPF certification

VERT – Project (1993 – 2000)

Verbesserung der Emissionen von Realmaschinen in Tunnelbau

Improvement of emissions of the real machines in tunnel construction.

Today (since 2008): Verification of Emission Reduction Technology

Objectives

- to diminish the emissions at the source
- to define the new limit values of emissions
- to find the methods and apparatus to control the machines in the field
- to confirm the feasibility of the particulate traps (PT) and regeneration systems in the field tests
- to give support to the users by introducing the PT-systems

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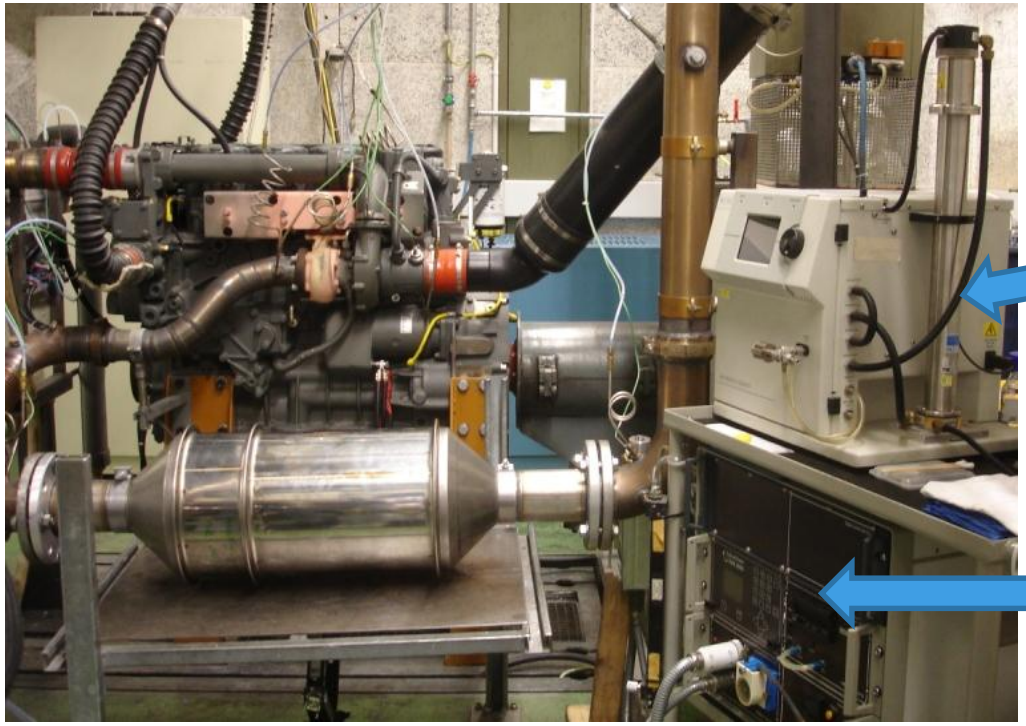
Lessons from VFT Engine dynamometer

VFT … VERT Filter Test

Equipment for nanoparticle measurements



SMPS

NanoMet

Emissions of solid particles from Diesel engines

1995

gravimetry

PM …particulate matter

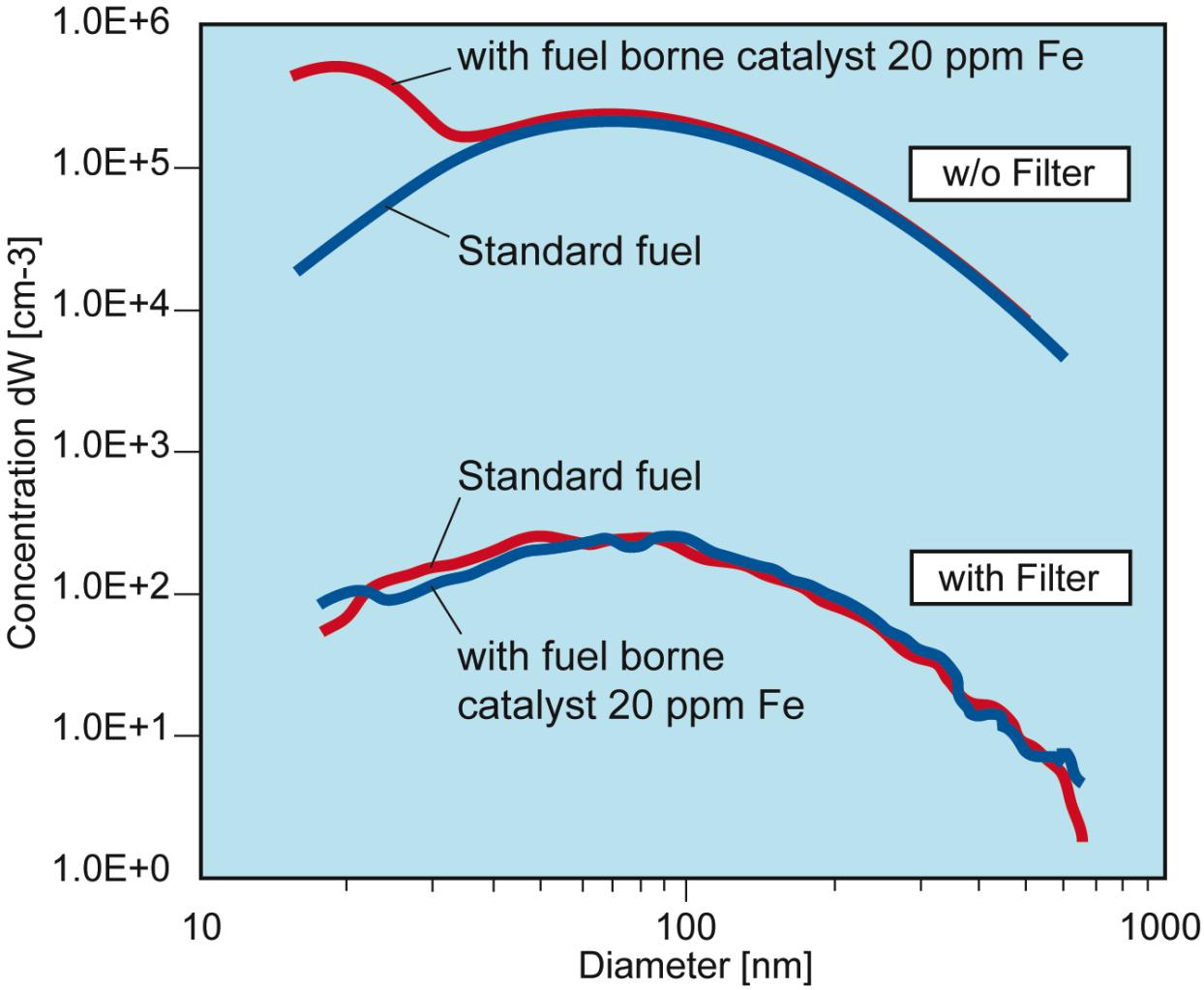
actual Legislation

counts

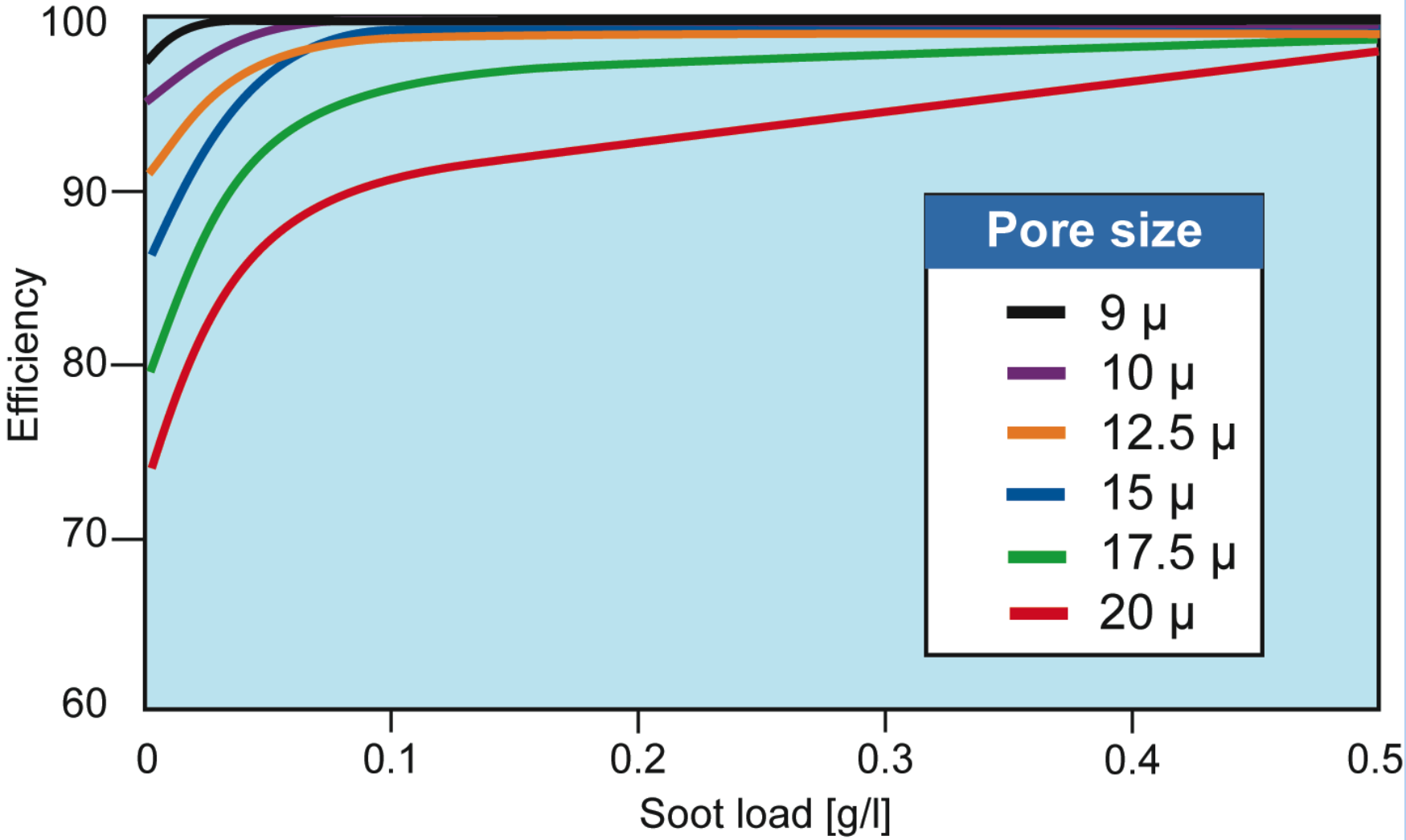
PN …particle number

new component

Bimodal particle distribution with FBC, with and without filter.



Filtration efficiency as a function of soot burden and pore size



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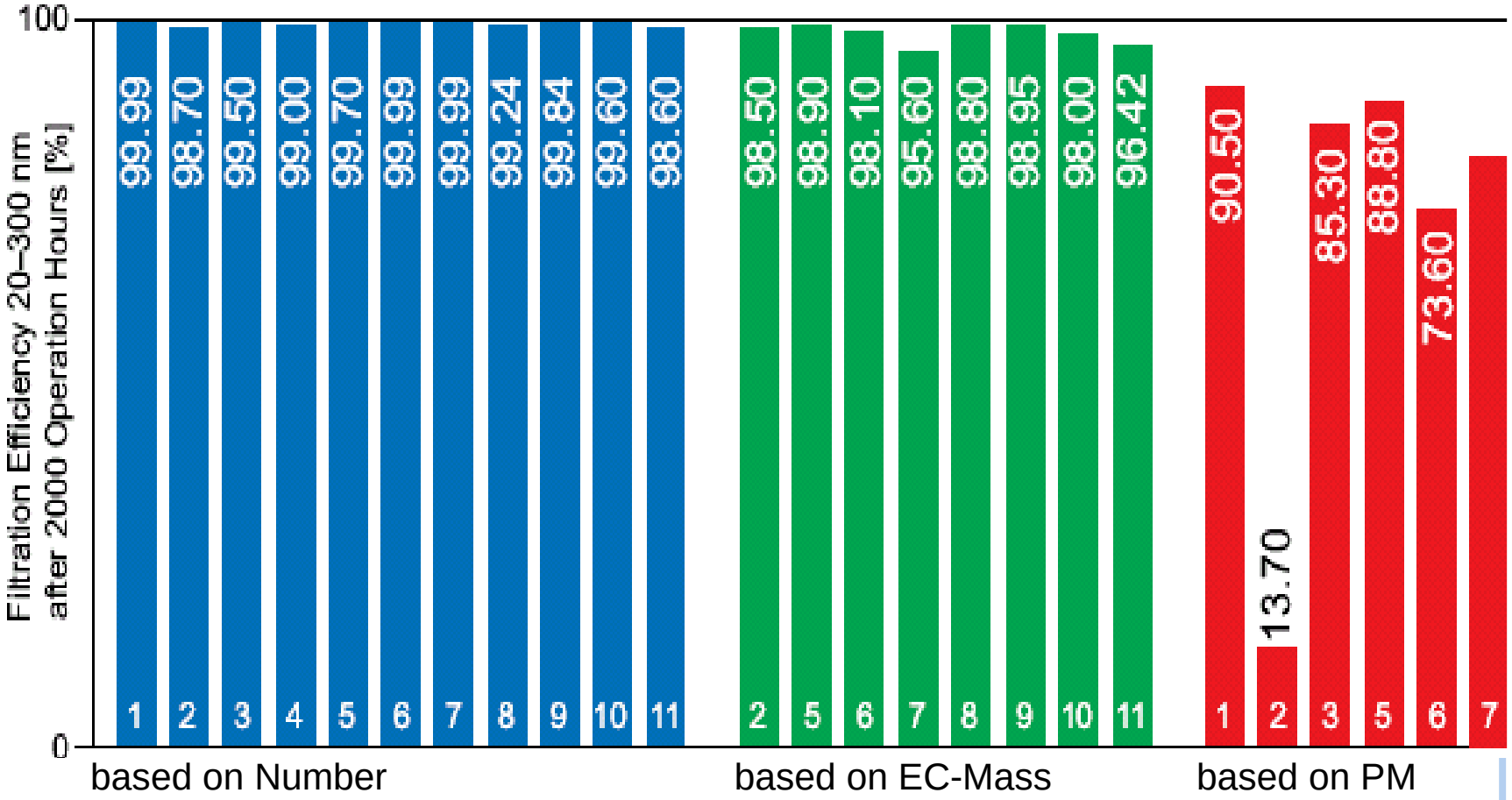
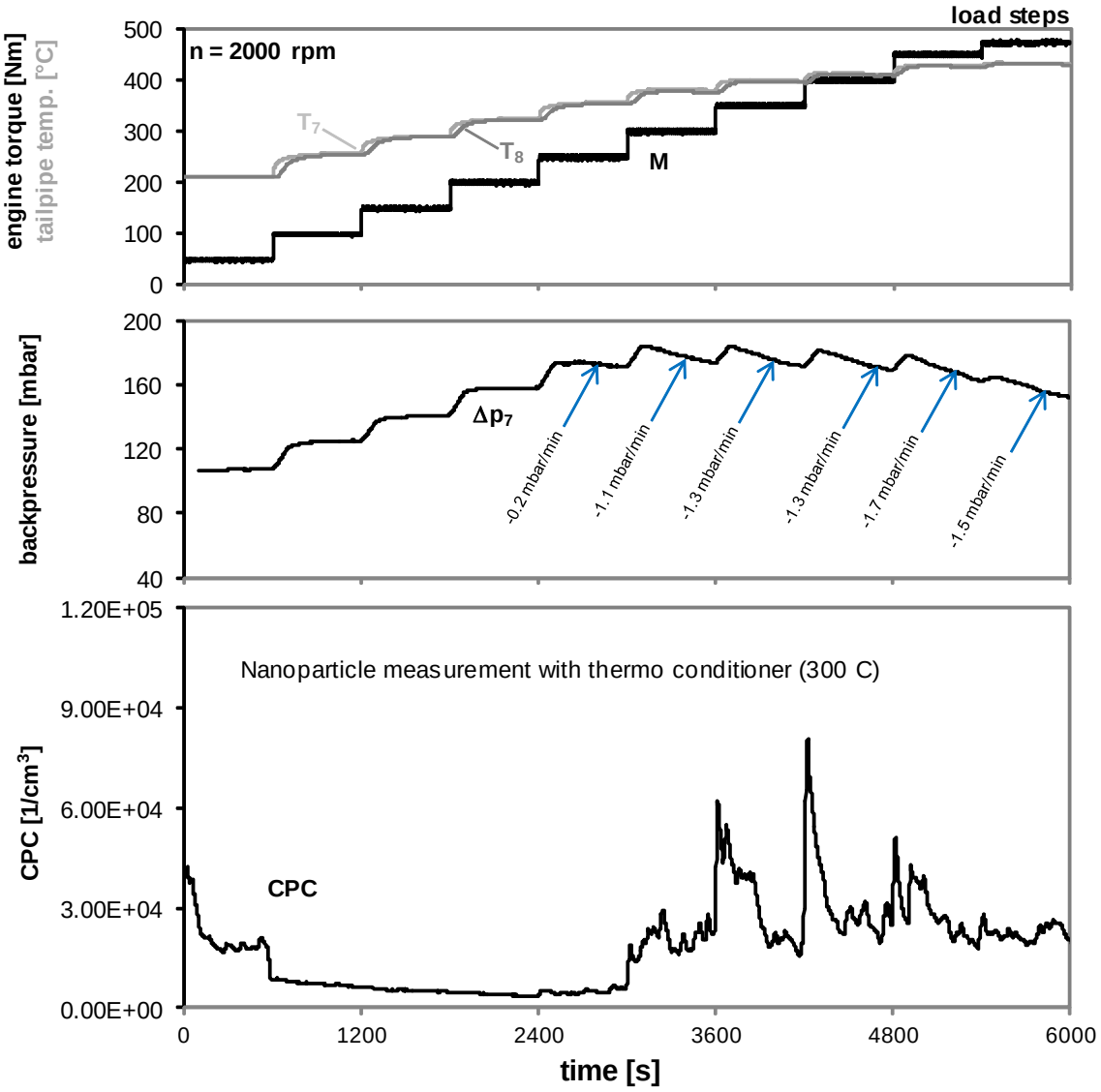
VERT Particle Filter-Verification (all Systems after 1998)

ISO 8178 Test-Cycle. Number by TD+SMPS+CPC.
EC-Mass by Coulometry. PM as usual



REGENERATION OF DPF, 40 PPM FE



Lessons from Fieldtests (2000h)

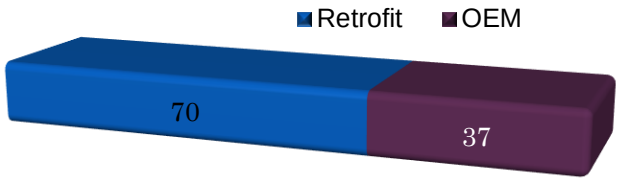
Lessons from Fieldtests (2000h)

- information, education & motivation of personnal
- datalogging (remote control)
- inspection & maintenance
- responsibilities: user, retrofitter, manufacturer of engine

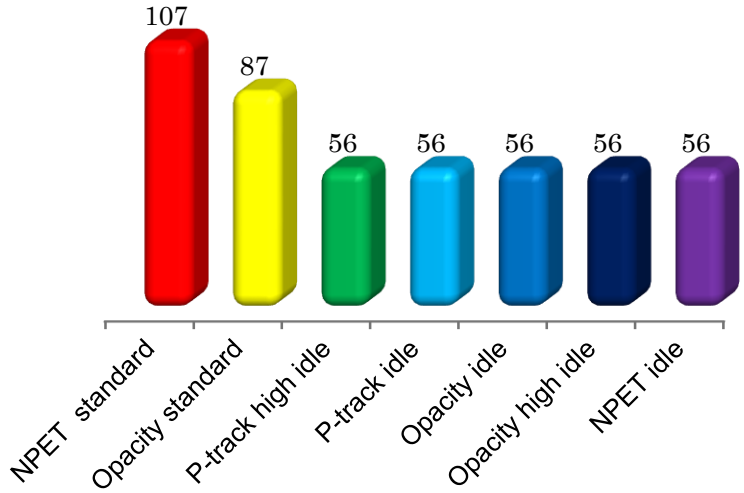
Field Control

Field Control with PN and Opacity

107 machines 2016-2017



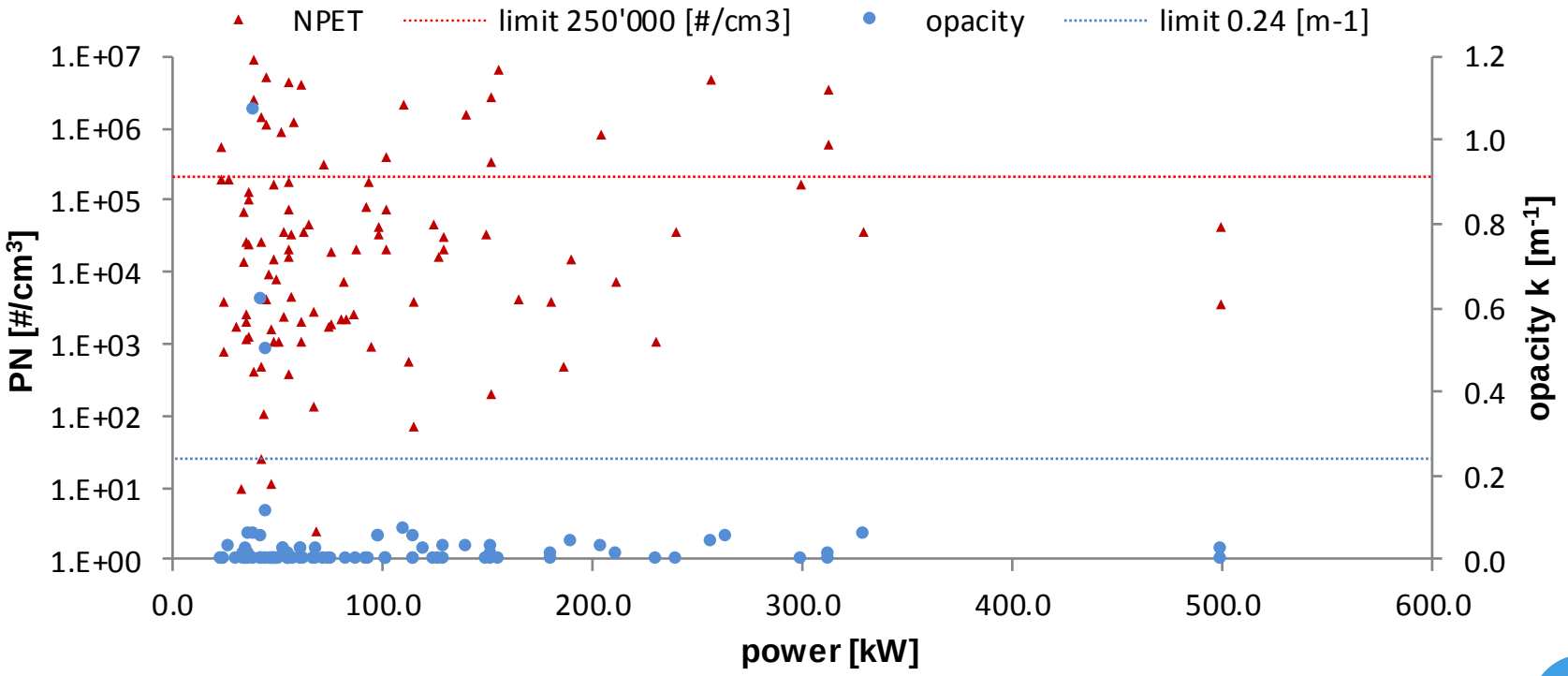
Repartition between retrofit and OEM DPFs



Samples of each measurement types

COMPARISON NPET@HIGH IDLE ↔ OPACITY@FREE ACCELERATION

107 machines 2016-2017



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Lessons from VSET

VSET … VERT Secondary Emissions Test

Some substances or substance constellations in the coatings can cause increased production of PCDD/F

www.vert-certification.eu
www.vert-dpf.eu

VERT® Filter List

Tested and VERT® certified
Particle Filter Systems and Particle Filter Components
Representing Best Available Technology BAT
Version September 2018

recognized by:

- Austria: AUVA*, Tyrol, Vienna
- Canada: DEEP*
- Chile: MMT*
- China: VECC*, BJ-EPB*
- Colombia: SDA Bogotà*
- Denmark: DTI
- England: LEZ London
- France: CRAMIF*, INRS
- Germany: BG BAU, UBA, TRGS* Berlin
- Hongkong: KBM, NWFB*
- Iran: AQCC Tehran, DOE*
- Israel IMEP*
- Italy: South Tyrol
- Mexico Ciudad: SEDEMA*
- Netherlands: VROM
- New York: City* + Port*
- Switzerland: BAFU*, SUVA*, ASTRA*
- USA: CARB, MSHA*

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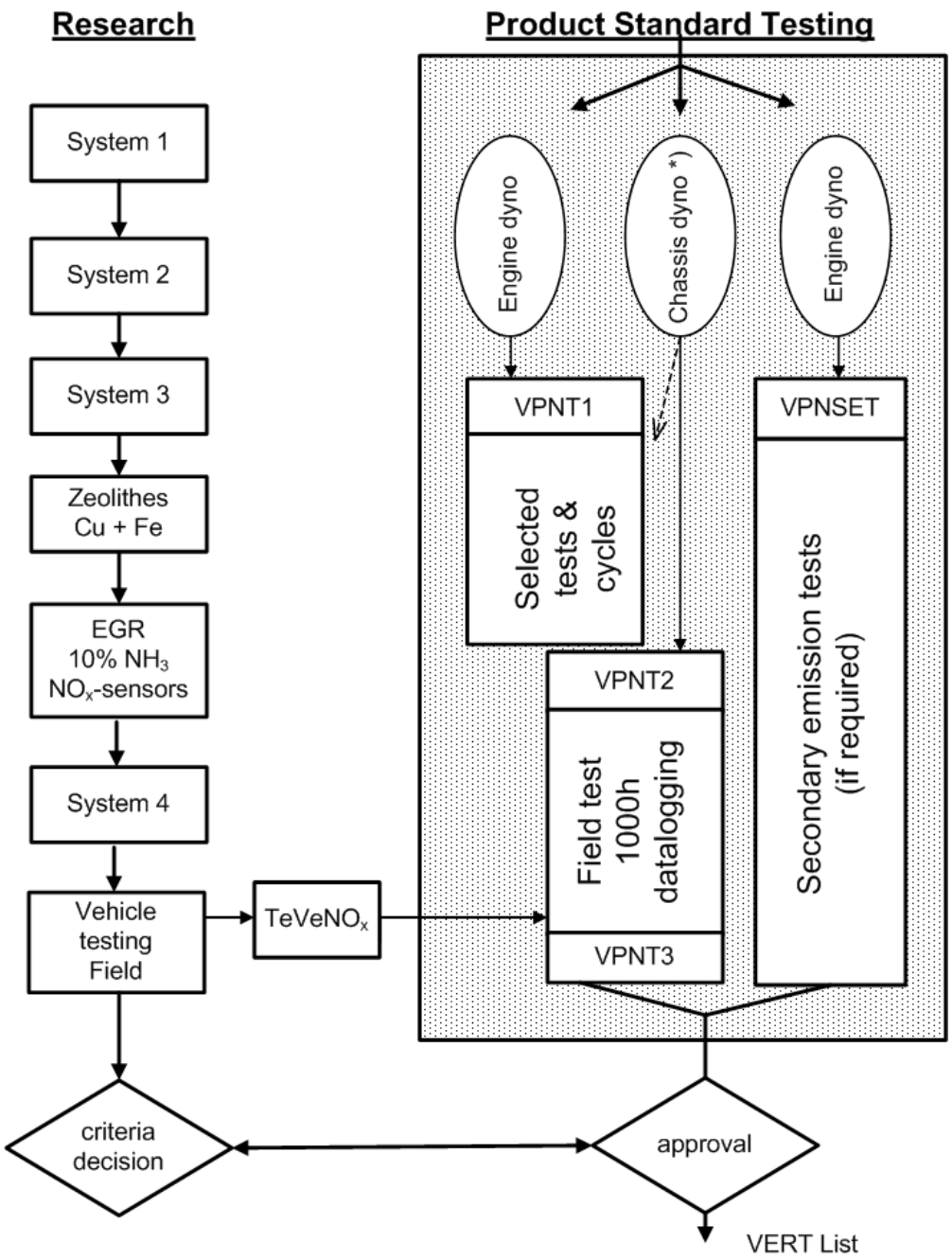
VERTdePN & TeVeNO$_x$

VERT …
Verification of Emission Reduction Technology

dePN …
decontamination Particles & NO_X



VERTdePN Testing Procedure for DPF+SCR Combisystems Product Standard (DPF VERT certified)

Target: recommendation on the VERT-List

*) VPNT1 on HD chassis dyno only with special equipment in justified cases

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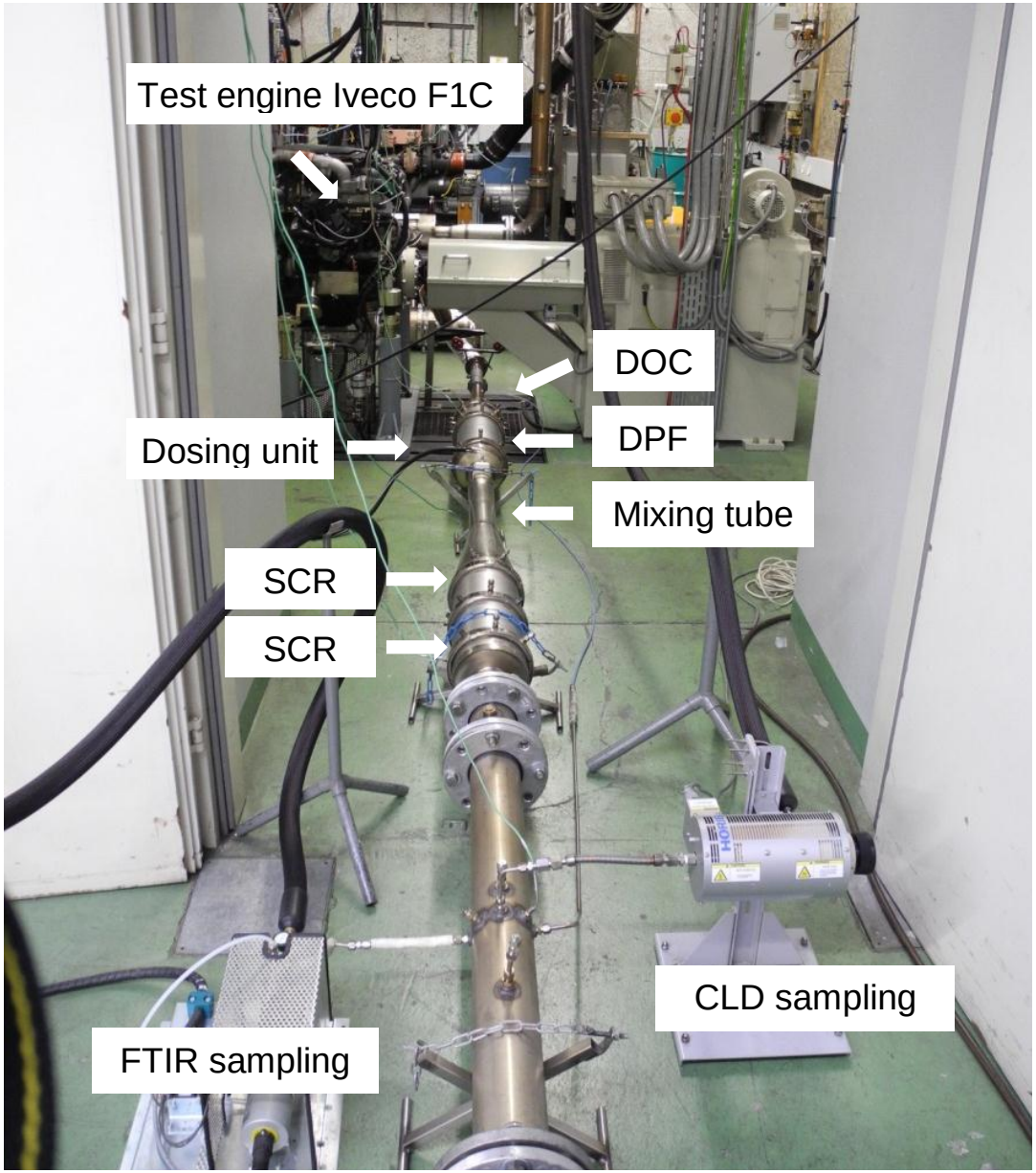
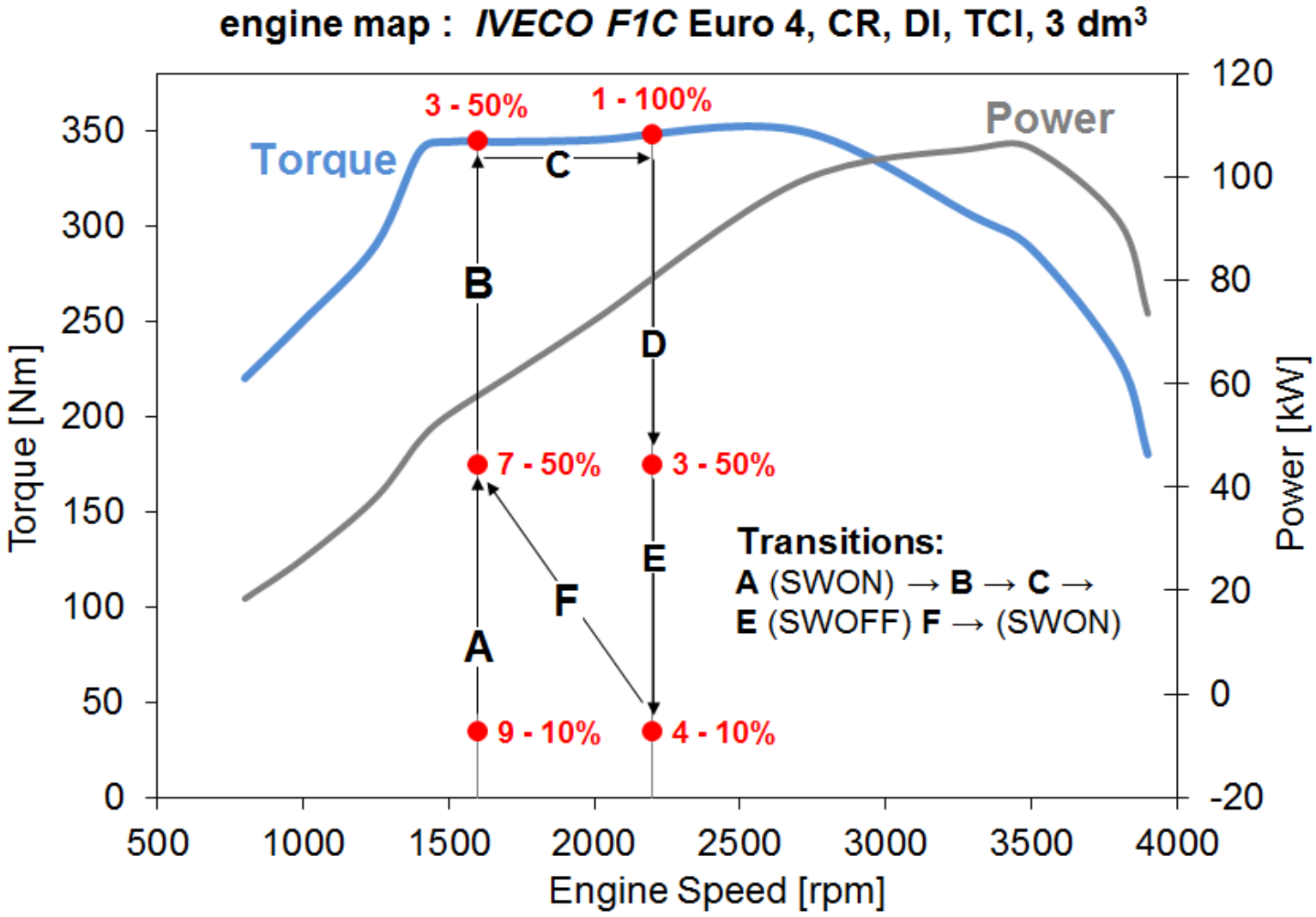


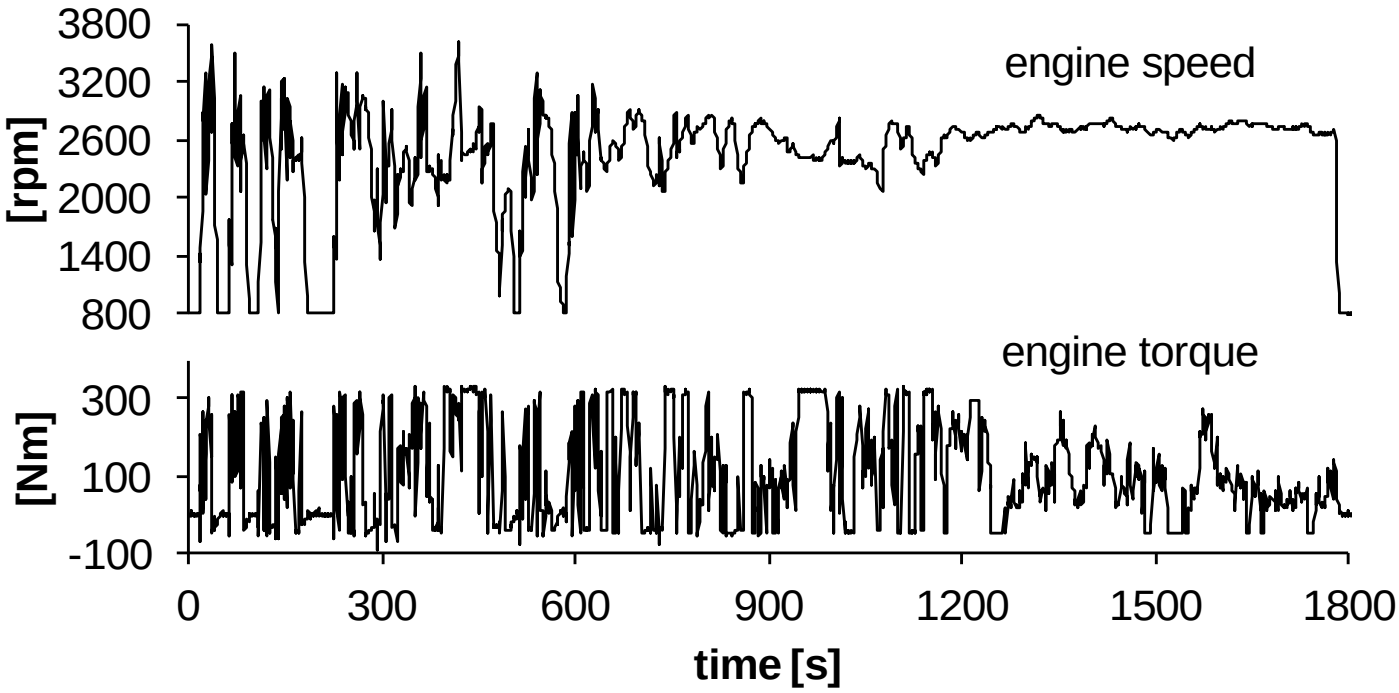
Adaptation of the (DPF+SCR) system on the test bench

Paper N° 2014-01-1579

Engine Map of the IVECO F1C and 6-Points-Test for DPF and for SCR Investigations



Torque & Speed in ETC IVECO F1C



Paper N° 2014-01-1579

VERTdePN
2007-2011

BAFU, ASTRA, SUVA
AFHB, EMPA, UMTEC
TTM, DINEX, HUG,
HJS

TeVeNO$_x$
2012-2013

ASTRA, BAFU,
AFHB, EMPA,
MAE, TTM

Paper N° 2014-01-1569

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TeVeNOx …

- Testing of Vehicles with
- NOx-Reduction Systems

Paper N° 2014-01-1569

3 Types of Vehicle Tests

Test Type 1

- **HD Chassis Dynamometer**

Test Type 2

- **Parcours on the Road (real world operation)**

Test Type 3

- **Simple Function Test (short operation on the road)**

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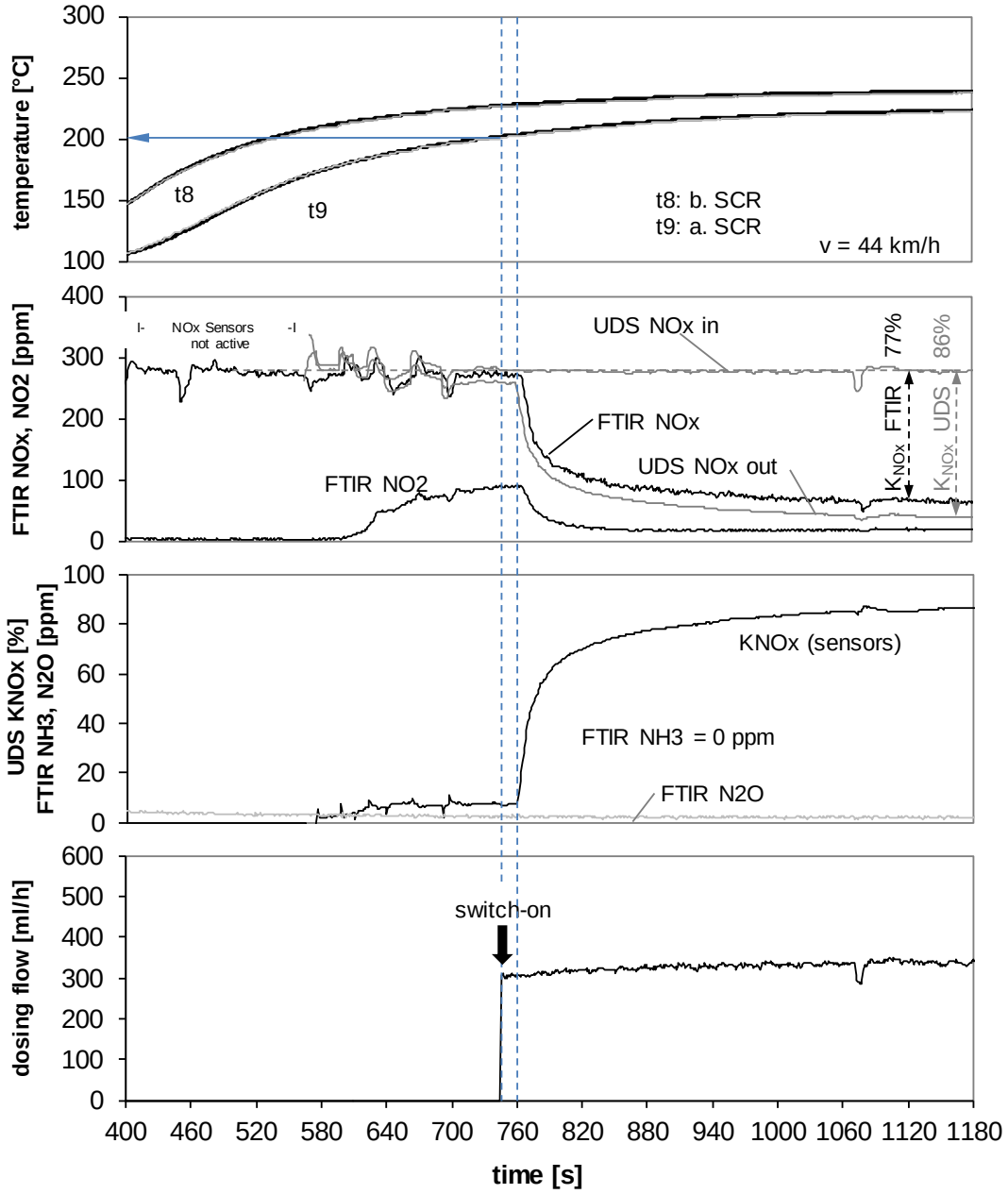
Vehicle E on the MAN HD chassis dynamometer with OEM SCR & retrofitted DPF

Paper N° 2014-01-1569



Switch-on Dosing

retrofit system cDPF & SCR; α = 0.75
vehicle A; ULSD; Chassis Dyno

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General Conclusions

- The foundations for the quality verification procedures of SCR-systems are established,
- The SCR-systems are not active at lower temperatures < 200°C,
- SCR-testing on vehicle has more importance (than DPF-testing) and it is a simple & low-cost tool for quality check.

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PN@RDE → GPF

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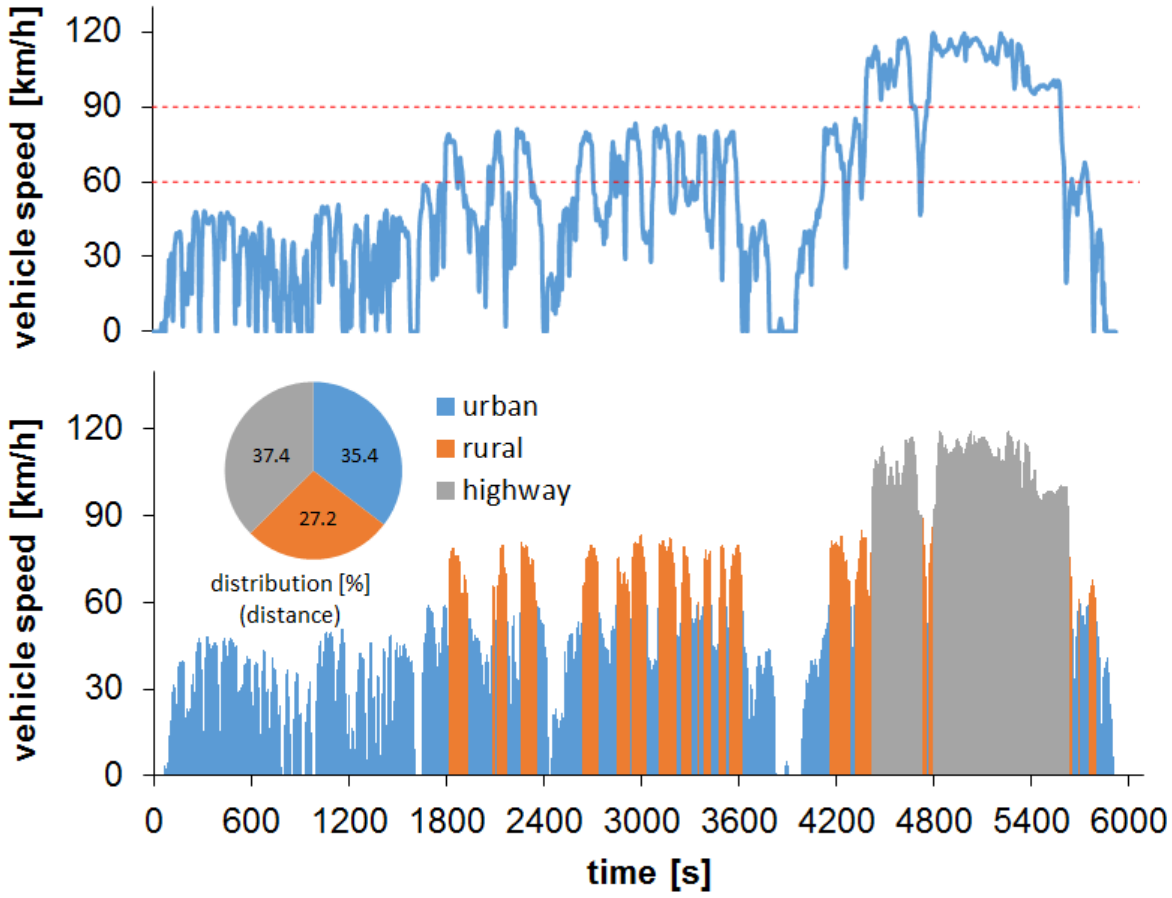
JRC Round Robin with PN PEMS

AFHB, ROAD TRIP FOR RDE; VEHICLE 1, PEMS 4 & PN PEMS



distance	
urban	31.8 km
rural	24.4 km
highway	33.6 km
total	**89.9 km**
time	
urban	53.2 min
rural	19.8 min
highway	18.7 min
stops	7.7 min
total	**99.4 min**
average speed	
urban	35.8 km/h
rural	74.1 km/h
highway	108.1 km/h
max	119.6 km/h

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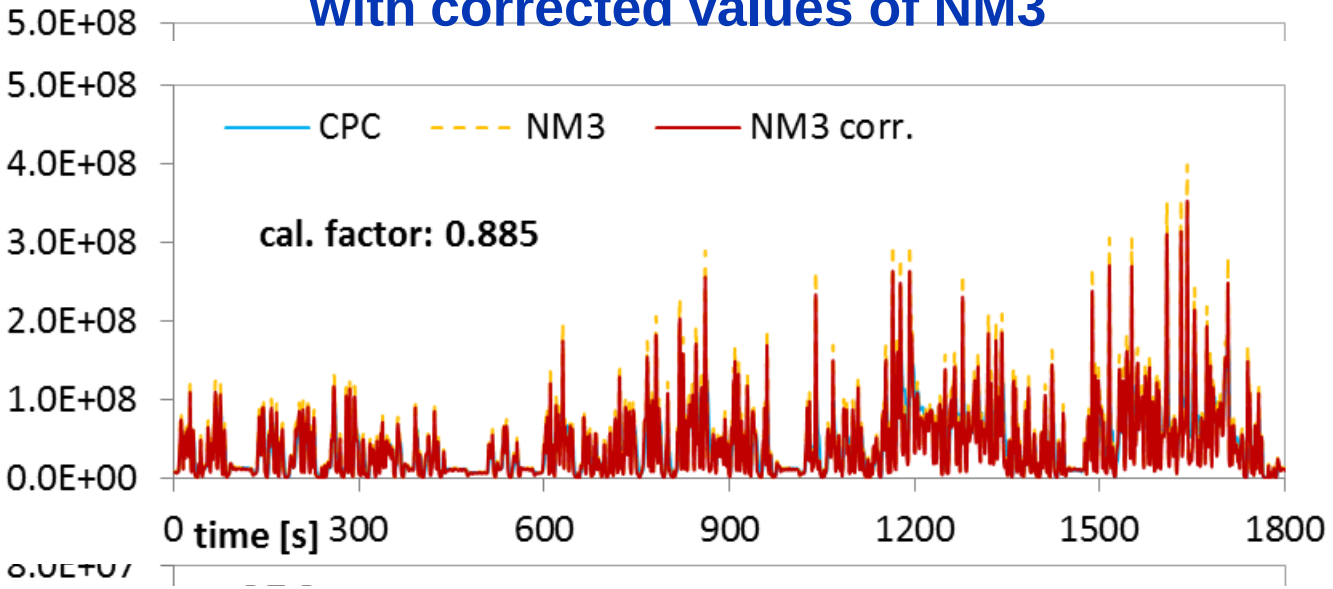
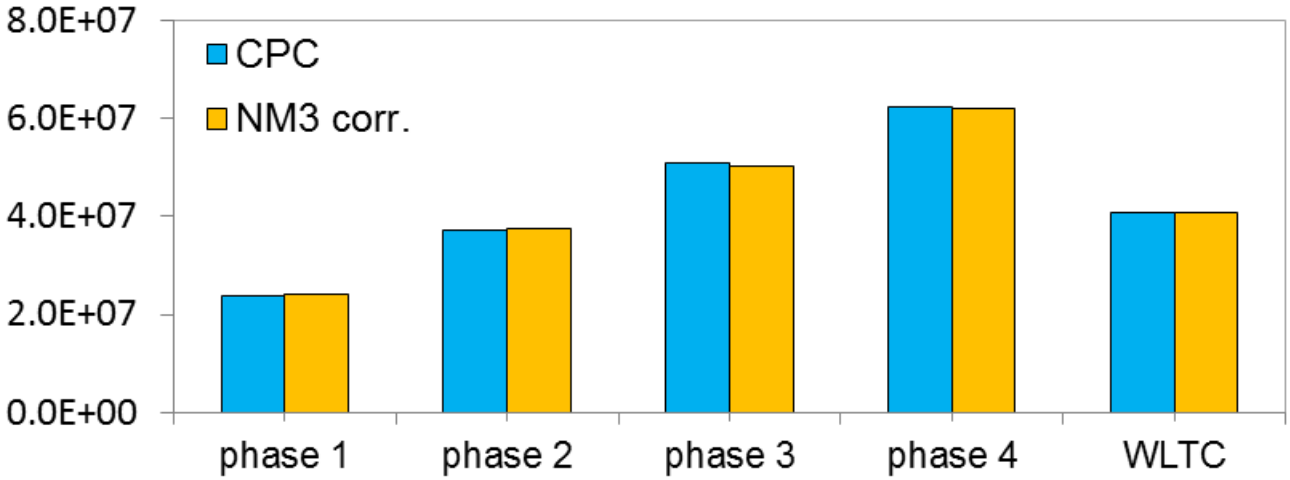
Comparison PN-PEMS ↔ CPC (PMP) by WLTC warm.

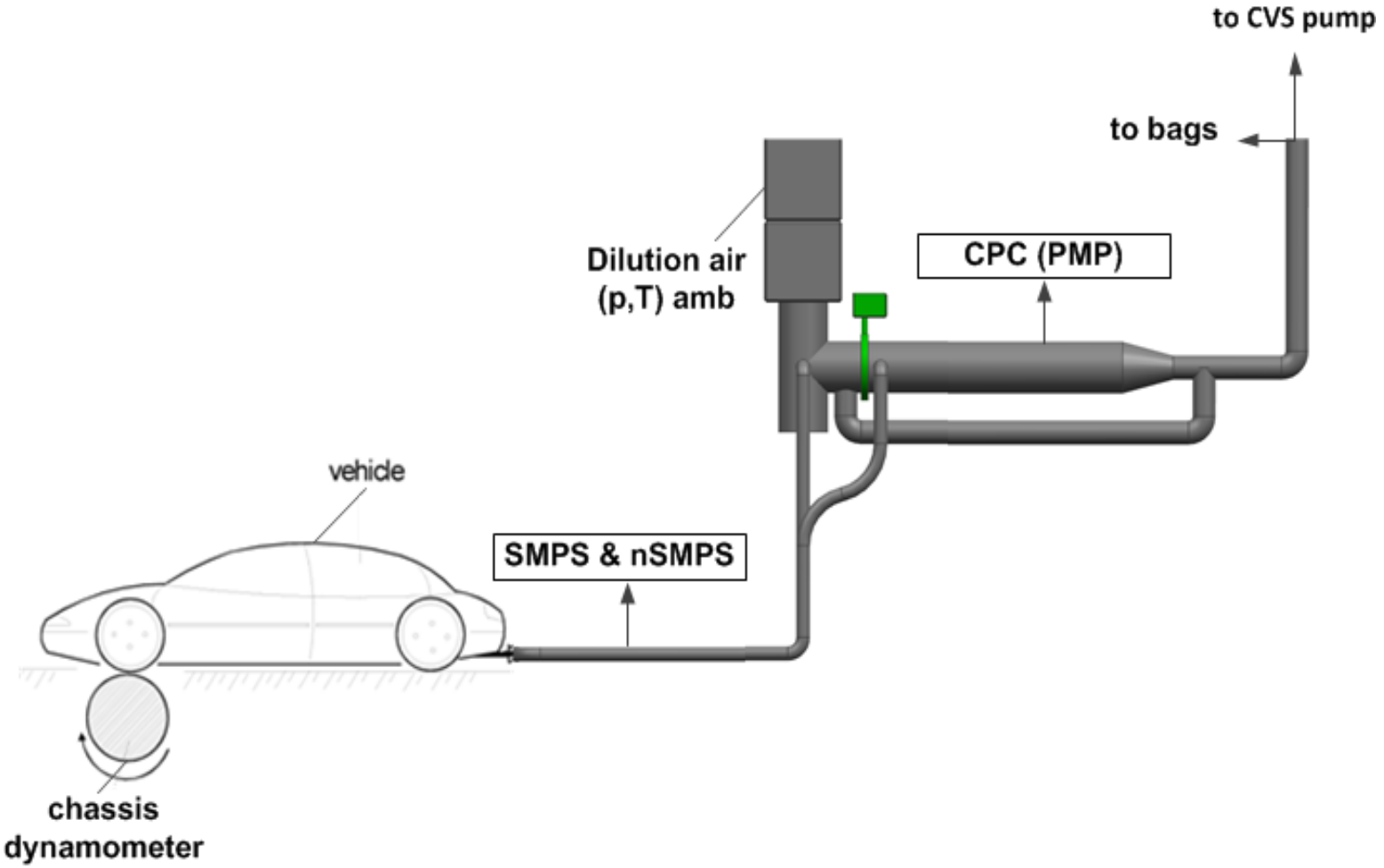
vehicle 6; DOC; fuel: Diesel

with corrected values of NM3





Set-up of exhaust gas sampling for PN-analysis



PN Measurements

- **Steady state (SSC)**

  SMPS, nSMPS at tailpipe

- **Transient operation**

  CPC in CVS tunnel

SAE 2017-01-1004

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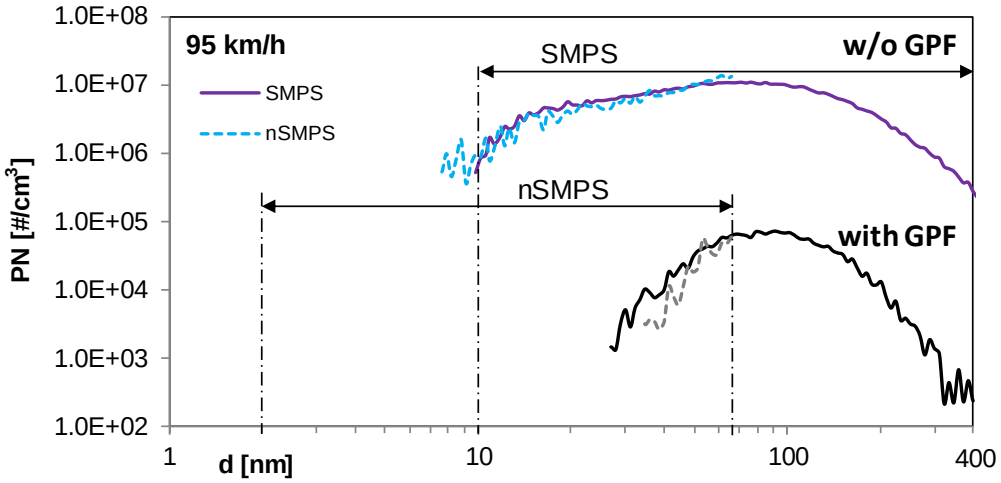
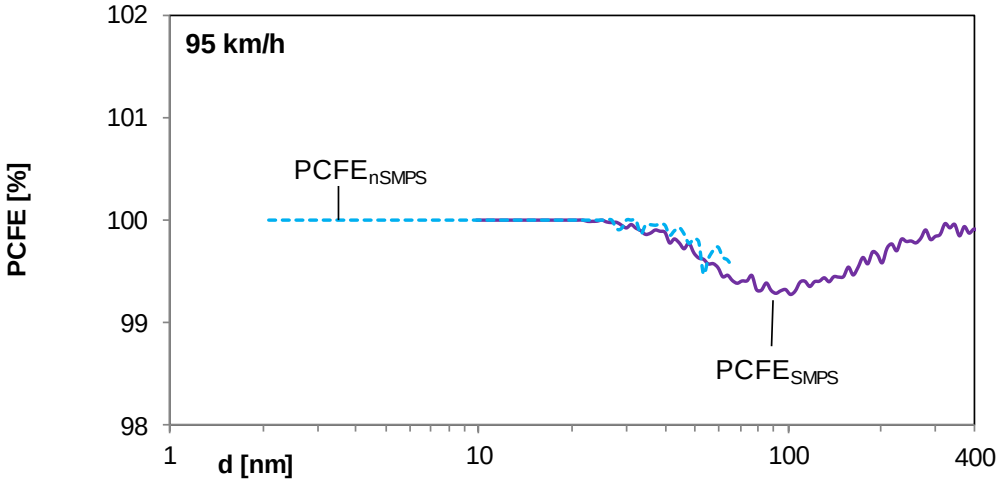
EXAMPLE OF PSD'S WITH SMPS & NSMPS AND PARTICLE COUNTS FILTRATION EFFICIENCY (PCFE) WITH V1, GPF 1 AT 95 KM/H





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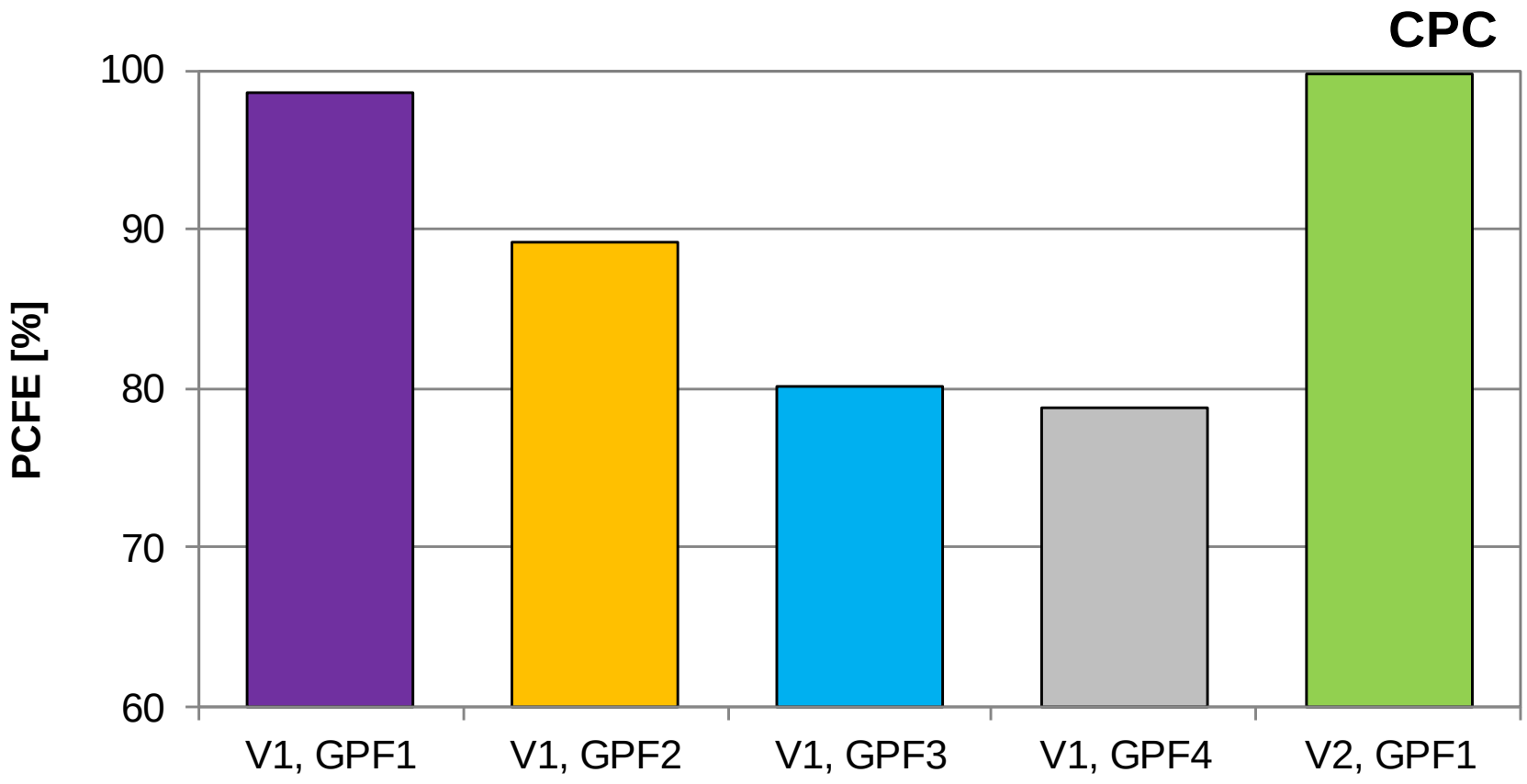
PCFE'S OF THE INVESTIGATED GPF'S IN WLTC HOT



SAE 2017-01-1004

Conclusions

- the PN-emission level of the investigated GDI cars in WLTC without GPF is in the same range of magnitude very near to the actual limit value of 6.0 x 10^{12} #/km
- with the GPF's with better filtration quality it is possible to lower the emissions below the future limit value of 6.0 x 10^{11}#/km
- the filtration efficiency of GPF can attain 99% but it can also be optimized to lower values – in this respect the requirement of "best available technology for health protection" should be considered

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NPTI

new periodical technical inspection

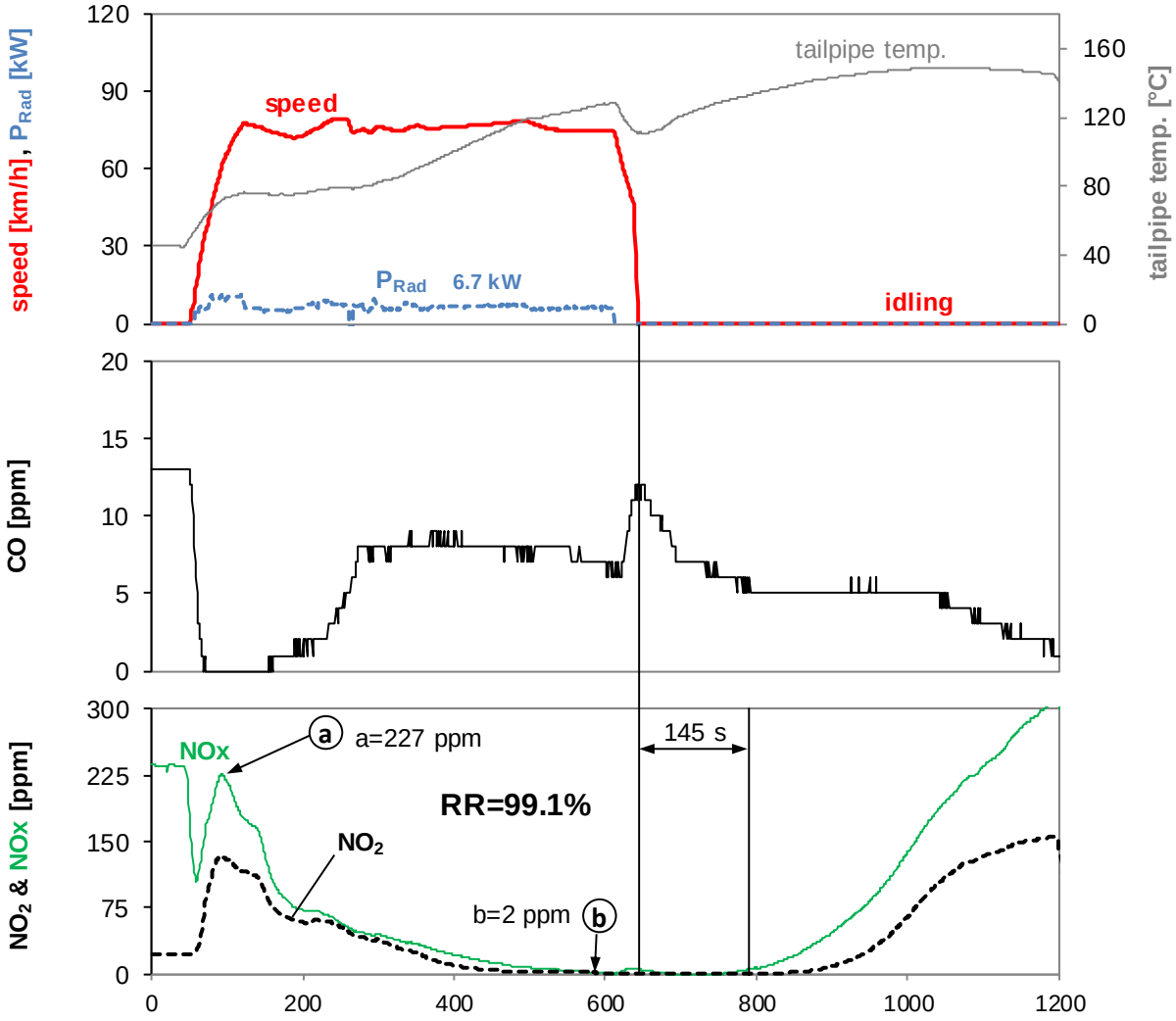
International Working Group since April 2016

EC JRC, BAFU, ASTRA, METAS, TNO, VERT, TTM, Sen. Berlin, UBA, Bast, TSI, TESTO, AK Wien, FHNW, AFHB

You can join!!!

IUCD: exhaust emissions during const. speed and idling.

Vehicle 3; EGR, DOC, DPF, SCR; fuel: Diesel; tailpipe.



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VERTdeNO$_x$

for Diesel passenger cars

If public support ?

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VERTdeNO$_x$ Testing Procedures for HD/LD SCR-retrofit

Vehicle equipped with a VERT-conform DPF-system

VdeNO$_x$1

Step-tests

on chassis dynamometer

- light-off
- max. gas flow
- max. temp.
- K_{NOX}
- gaseous emissions incl. NH_3

VdeNO$_x$2

RDE

on road circuit

- 3 repetitions
- Gas PEMS
- PN PEMS

VdeNO$_x$3

Durability

in customer application

- data logging
- AdBlue consumption
- control after 10'000 km

VdeNO$_x$4

End check

on road circuit

- results from VdeNO$_x$3
- short RDE
- simple function test

Abbreviations

HD … heavy duty
LD … light duty
K_{NOx} … NO_x conversion efficiency
PN ... particle number
RDE ... real driving emissions
PEMS ... portable emission measuring system

Conclusions

- **With DPF, SCR, GPF it is possible to:**
  - **Eliminate PN and**
  - **Reduce NO_x below the legal limits**
- **Quality control in-use is possible (for deNO_x PTI more effots are necessary)**
- **Quality procedures for new deNO_x systems for Pcars are elaborated.**

Na zdrowie !

Gesundheit !

Lechajim !

up to your health

Santé !

La-briut !

Salute !