PTI PN TEST PROCEDURE

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*PTI = Periodic Technical Inspection
PN = Particulate Number

GOVERNMENTAL EVENTS

- 2012: Request from national policy officers to TNO to investigate the possibilities for checking DPF's in the Periodic Technical Inspection (PTI)
- 2015: Discussion between members of the Dutch Parliament and Secretary of State about the missing test to check DPF's in the PTI. The secretary promised to investigate new PTI emission tests.
- 2019: Publication in the Dutch 'Staatscourant' of the new regulation for a PTI PN test (test procedure, specification of a PTI-PN counter, PN limit values).
- 2021: Expected date for the implementation of the PTI PN test for vehicles with a DPF.

1. DPF: 95 - 99% REDUCTION OF PM

- What was changed in 2009 with the implementation of DPF's?
  - 1970 - 2009, Euro 1 to 4 and I to V: determination of the **quality of the combustion; smoke numbers (k) = 0,3 – 2,5 (+/- 0,3)** on a scale of 0 – 10 m^{-1}).
  - 2009 – 2018, Euro 5,6, VI: Determination of the **filtration efficiency of the DPF**; smoke numbers are extremely low (**k = 0,0 – 0,1 m^{-1}**).

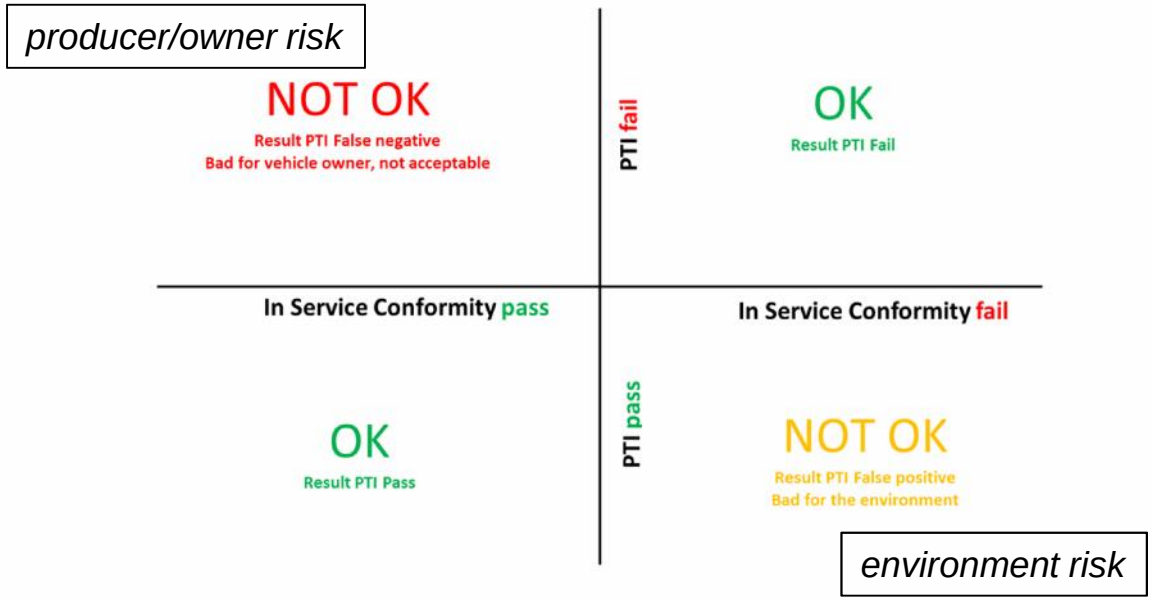
Due to extremely low particulate emission levels a new PTI emission test for DPF's is needed.

- From 2012 to 2019 the Dutch Ministry of Infrastructure and Water Management has funded several projects for the development of a new PTI test procedure for diesel particulate filters.

1. REQUIREMENTS PTI EMISSION TEST

- Fast and easy operation (i.e. 30 seconds and a simple test).
- Low cost emission tester (< 5000 Euro), easy calibration.
- Repeatable and reproducible procedure.
- < 3% false positive and no false negative test results.
- Less stringent than type approval and In Service Conformity levels.

1. RELATIONSHIP OF ISC AND PTI TEST PROCEDURES



Pass/fail criteria of the PTI test must be related to the pass/fail criteria of the in-service conformity or type-approval test but less stringent.

1. CURRENT STATUS OF DUTCH PTI DPF PROGRAM

- The new PTI DPF test protocol (Periodic Technical Inspection) will be finalised and published in 2019 in the Dutch “Staatscourant”.

  1. Low idle speed test.
  2. Specification of a PTI-PN-tester developed by Dutch NMi.
  3. PN limit value of 250.000 – 1.000.000 #/cm^3.

- **The new PTI PN emission test procedure will be implemented in the Dutch PTI as soon as sufficient new PN-tester are on the market (2021).**

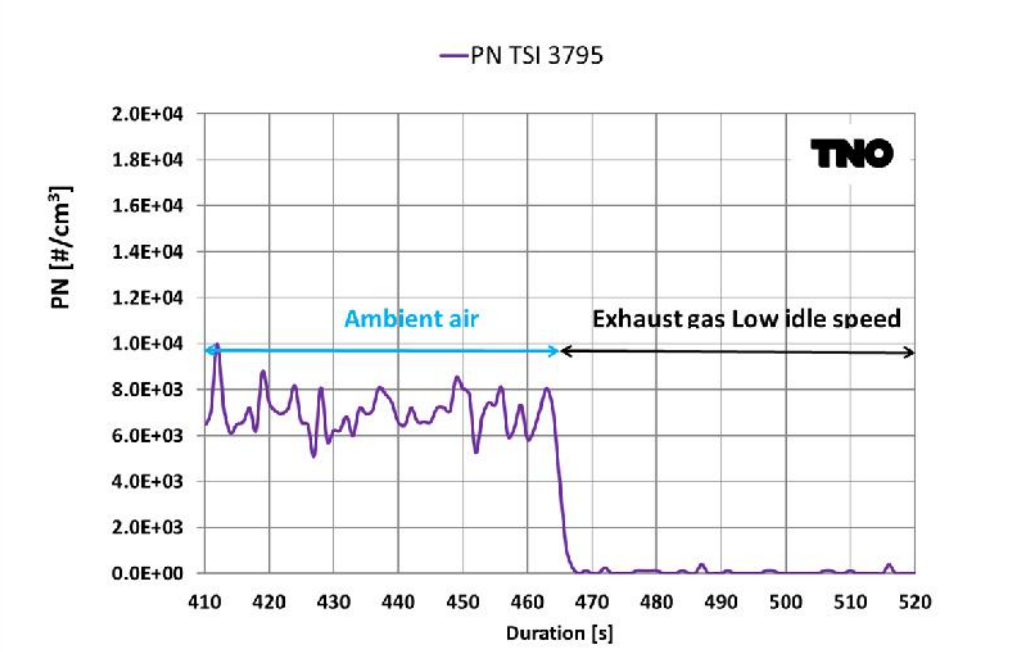
OPACIMETERS [M^{-1}] & PN TESTERS [#/CM^3]

K = 0 - 10 m^{-1}.

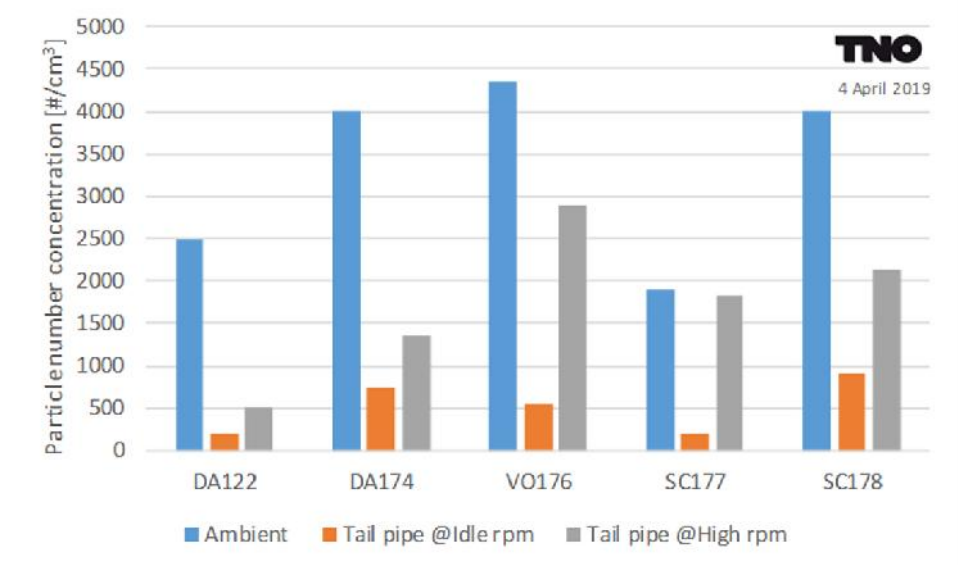
	> 23 nm	> 23 nm	> 20 nm	> 10 nm
	solid	solid	solid+volatile	solid+volatile
DF	100	10	1	1
Max.	5^E07	5^E06	5^E05	1^E05

2. PN EMISSION DPF @ LOW IDLE SPEED IS NEAR ZERO

PEUGEOT 308 EURO 6B DIESEL @ 105,000 KM

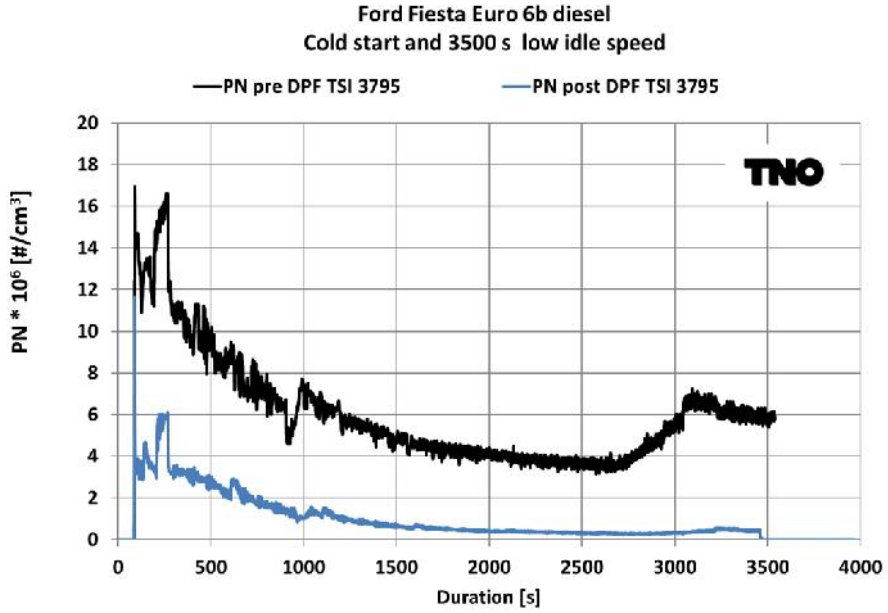


2. PTI PN EMISSIONS OF EURO VI VEHICLES



PN emissions @ idle speeds of Euro VI trucks are all below the PN concentration of ambient air.

2. PN PRE AND POST DPF DURING WARMING UP

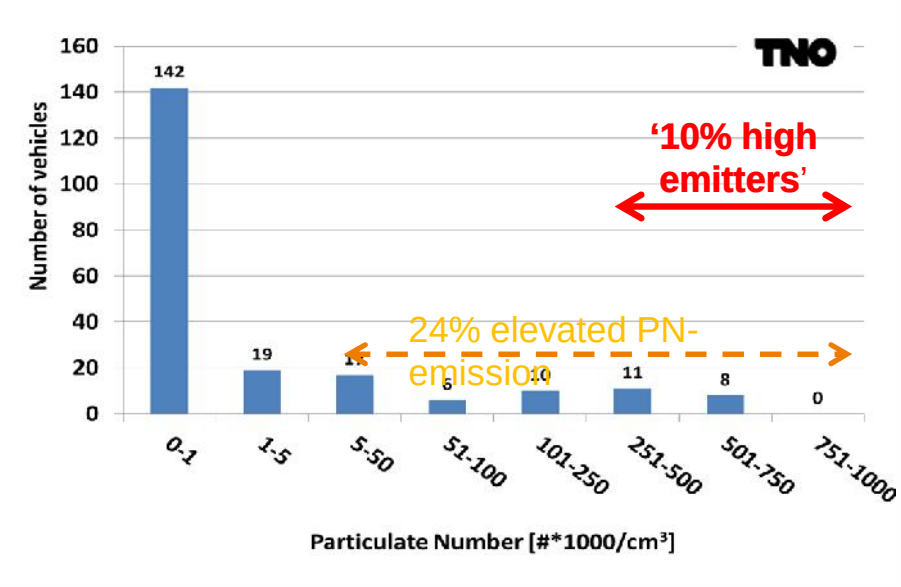


Note:
Two seperate idle tests

2. TNO 2015-2016: PTI VEHICLE SELECTION

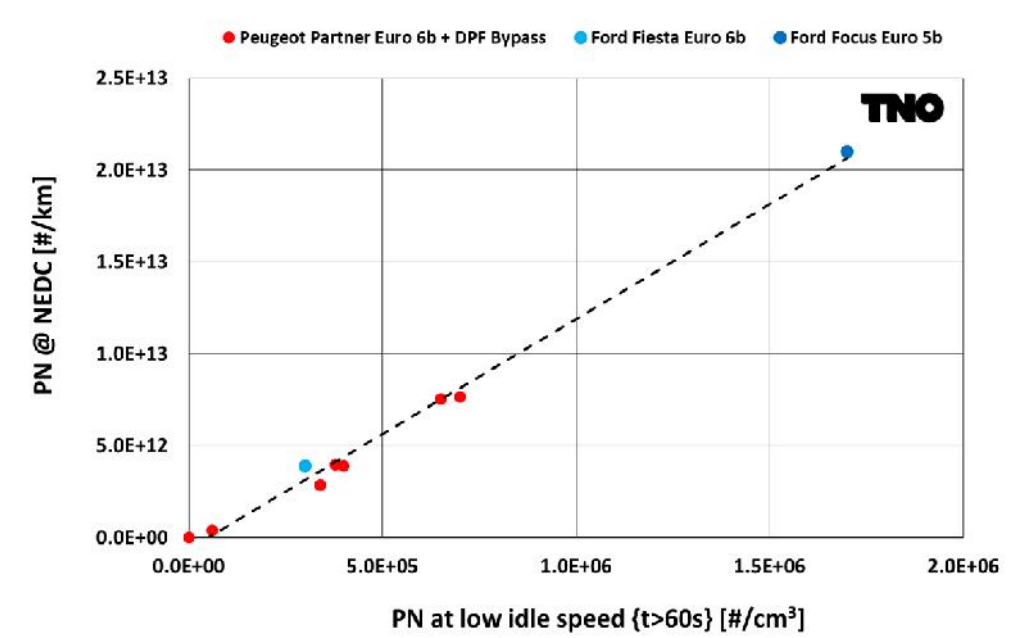
- Lease companies, service shops
- **220 vehicles** were selected at random at the 7 test locations.
- Age 2 - 5 years old @ 50,000 – 250,000 km
- Selection is not representative for the Dutch fleet (no private cars).
- Test period: December 2015 – February 2016.

2. PN EMISSIONS @ LOW IDLE SPEED



161 vehicles (76%) have a PN emission of < 5000 #/cm^3.
52 vehicles (24%) have an elevated PN emission of > 5000 #/cm^3.
10% of the vehicles have a PN emission of > 250.000 #/cm^3.

2. ISC-PN NEDC VERSUS PTI-PN @ LOW IDLE SPEED



PN (solid > 23 nm) @ low idle speed seems to have a good correlation with PN in the ISC-NEDC test for these vehicles. Additional validation is needed.

2. VERT: NPTI INFORMAL GROUP 2016 - 2019

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- **Development of a new PTI DPF emission test procedure**
  1. Definition of a relevant emission test. Finished.
  2. Definition and specification of a low cost PN-tester, Finished.
  3. Definition of a feasible PN limit value. Finished.

- *From 2016 to 2019 the informal NPTI workgroup worked mainly on the development of a new PTI PN tester. Scientists, (local) governments, a metrological institute, equipment manufacturers and policy makers from* ***Switzerland, Germany, Belgium, Netherlands and EC-JRC we****re involved and exchanged data and experiences.*

2. 2018 - 2019 PROGRESS VERT-NPTI GROUP

Potential suppliers of PTI-PN testers:

- TSI
- Testo
- Naneos
- Sensors
- AVL
- Dekati
- TEN
- MAHA
- Premier Diagnostics
- Pegasor
- Continental
- Mahle

Potential PTI market needs high numbers of instruments

2. DUTCH NMI: SPECIFICATION OF NEW PTI PN TESTER

- Solid Particles.
- Particle sizes: 23, 50 and 80 nm.
- Measuring range: 0 – 5.000.000 #/cm^3.

- Part 1: Specification of the tester
- Part 2: Calibration procedures
  - Type approval, Initial & in-field calibration.

- Certification is already possible in 2019. Contact details NMi: pkok@nmi.nl

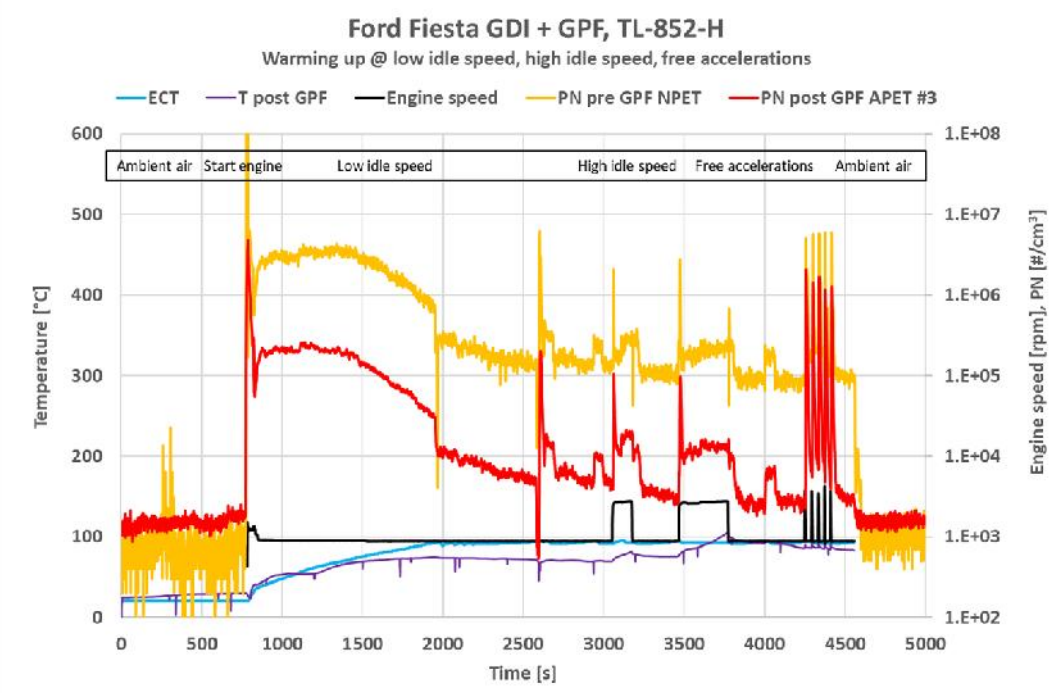
2. PARTICLE SIZES & COUNTING EFFICIENCIES OF PN TEST EQUIPMENT

Mobility Diameter [nm]	23	30	41	50	55	70	80	100	200	Accuracy
Chassis dyno min UNECE R83 max	0.38 0.62	-	> 0.90	-	-	-	-	-	-	+/- 0,10
PEMS min EC 2017/1145 max	0,2 0,6	0,3 1,2	-	0,6 1,3	-	0,7 1,3	-	0,7 1,3	0,5 2,0	+/- 0,10
PTI The Netherlands	0,2 0,6			0,6 1,3			0,7 1,3			+/- 0,25

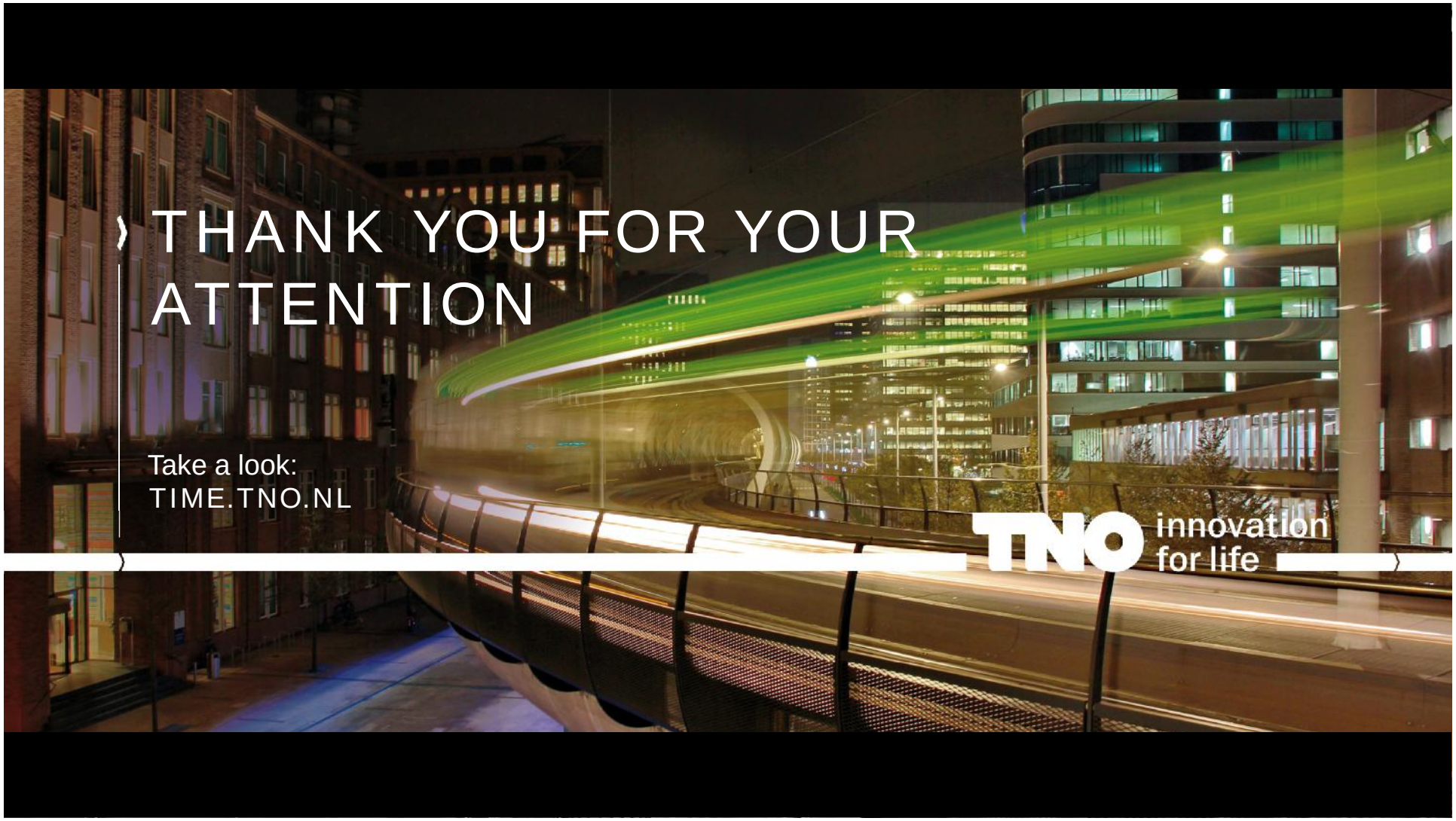
2. WORLD WIDE HARMONISATION OF THE PN TESTER

- Minutes 53rd CIML Meeting (OIML workgroup), Hamburg, Germany 9–12 October 2018
- *Resolution no. 2018/27 (agenda item 12.1.2.5) The Committee, Noting the comments made by its members on the details of the terms of reference included in Addendum 12.1.2.5, Approves as a new project, under the responsibility of TC 16/SC 1, the development of a new Recommendation on Instruments for measuring the vehicle exhaust soot particle number (PN), to be conducted as specified in the project proposal provided in the addendum 12.1.2.5 to the working document of this meeting.*
- Germany (PTB, Prof. Volker Ebert) and Netherlands (NMi, Mr. Paul Kok) are leaders of this new OIML project.

2. GASOLINE VEHICLES WITH GPF



PN emissions of gasoline engines are
- appr. 20 times lower than diesel engines.
- Substantial higher with cold engine
- Stable and low with warm engine


THANK YOU FOR YOUR ATTENTION
Take a look:
TIME.TNO.NL
TNO innovation for life

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- www.tno.nl/vehicle-emissions or www.tno.nl/voertuigemissies

- https://www.tno.nl/en/focus-areas/traffic-transport/roadmaps/sustainable-traffic-and-transport/sustainable-mobility-and-logistics/improving-air-quality-by-monitoring-real-world-emissions/emissions-of-particulate-matter-from-diesel-cars/

ABBREVIATIONS

- DPF = Diesel Particulate Filter
- DF = Dilution Factor
- FA = Free Acceleration
- ISC = In Service Conformity
- NEDC = New European Driving Cycle
- NMI = Netherlands Measurement Institute
- PM = Particulate Matter
- PN = Particulate Number
- PTI = Periodic Technical Inspection