

UPDATE PTI PROCEDURE FOR DPF TESTING

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Ministerie van Infrastructuur en Milieu

**DPF-PTI RESEARCH PROGRAM
RESULTS 2015-2018**

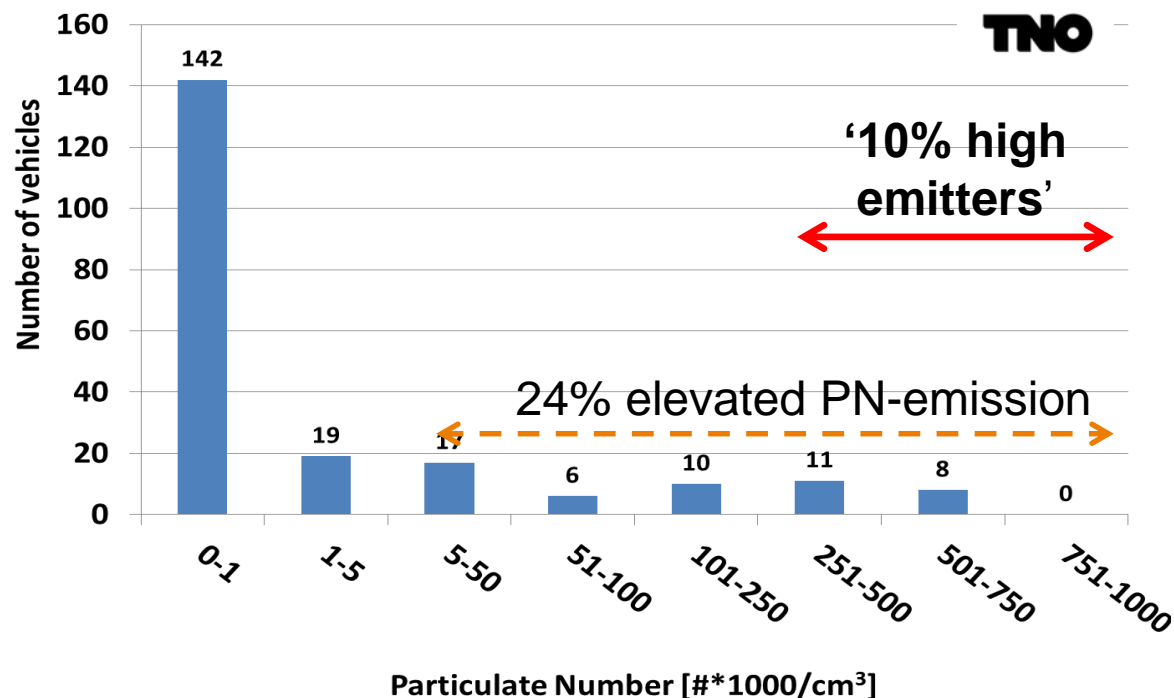
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OBJECTIVES DUTCH PTI DPF PROGRAM

- › Development of a PTI test protocol (Periodic Technical Inspection) to judge the performance of Diesel Particulate Filters (2013-2019).
 1. Definition of a relevant emission test
 2. Definition of a feasible PN limit value
 3. Definition and specification of a low cost PN-tester

- › **The PTI PN emission test, PN limit value and the new PN-tester are related and must be approached as a package.**

PTI PN EMISSIONS OF 220 VEHICLES

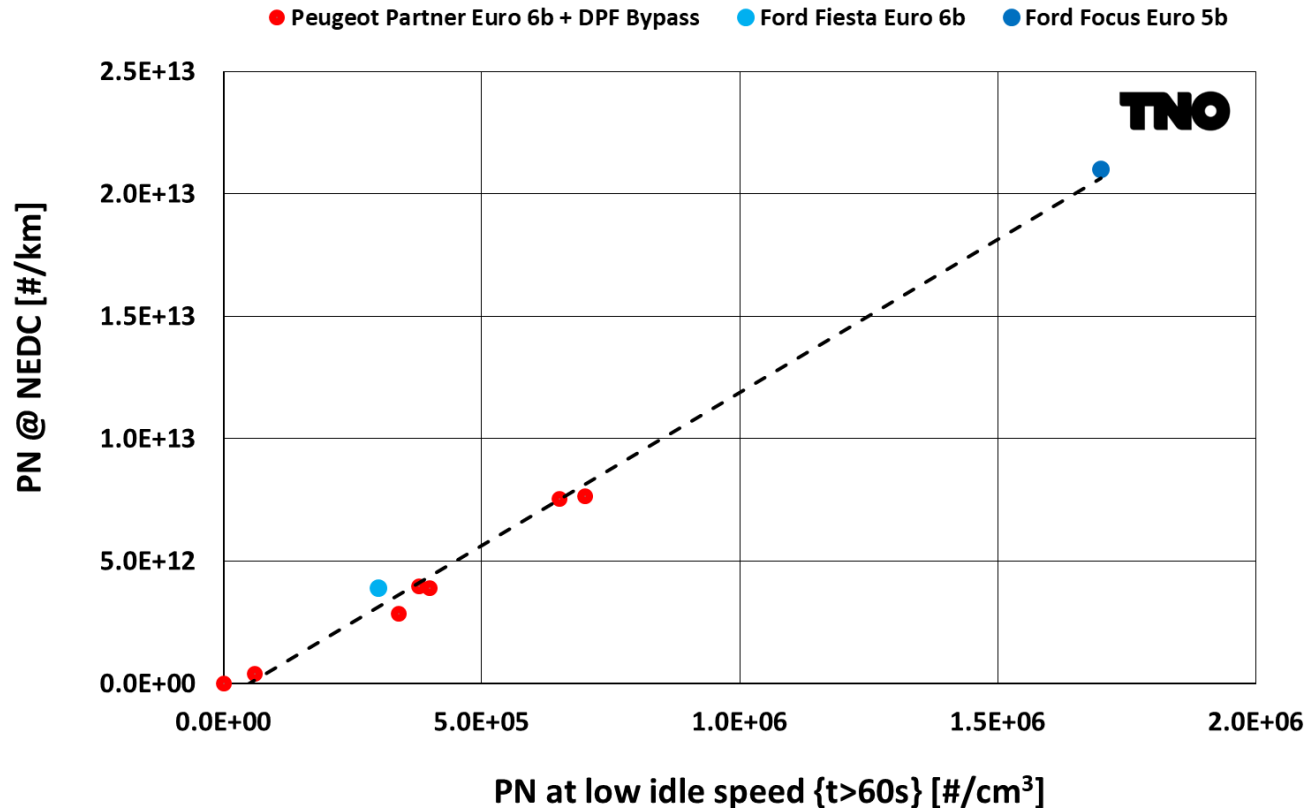


161 vehicles (76%) have a PN emission of $< 5000 \text{ \#/cm}^3$.

52 vehicles (24%) have an elevated PN emission of $> 5000 \text{ \#/cm}^3$.

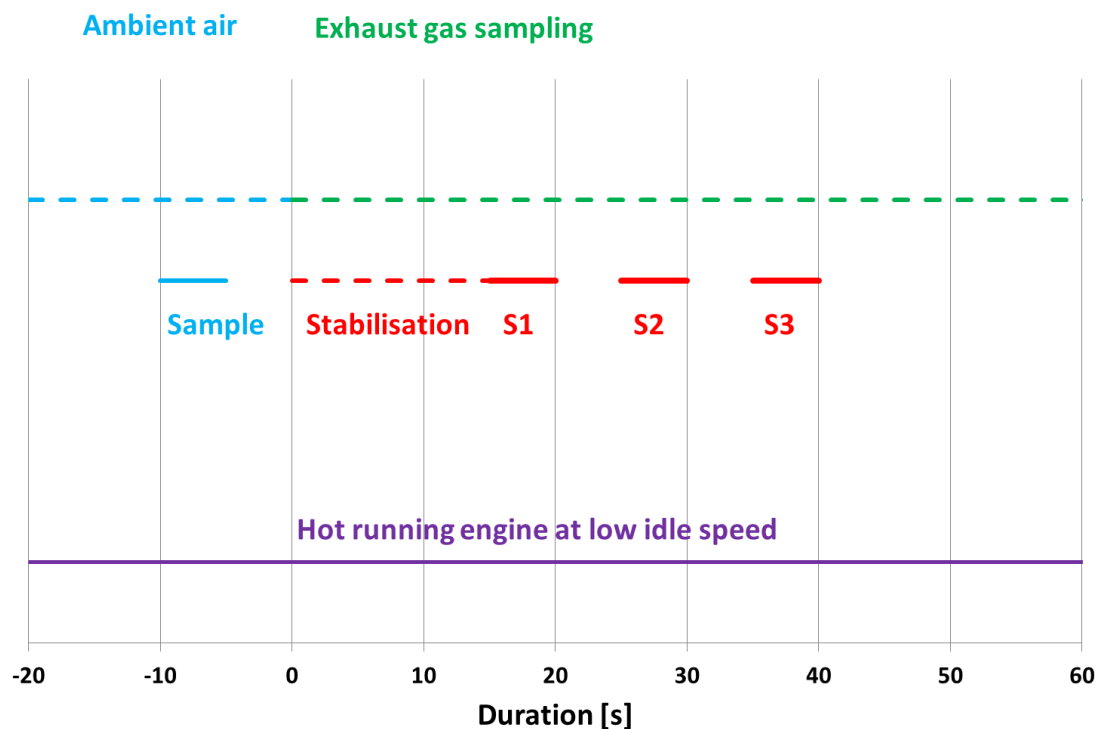
10% of the vehicles have a PN emission of $> 250.000 \text{ \#/cm}^3$.

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.

PROPOSAL NEW PTI TEST PROCEDURE



Low idle speed test.

New
specification of
PTI PN-tester

Proposed
PN limit values
250,000 –
1,500,000 #/cm³

The PTI PN emission test, PN limit value and the new PN-tester are related and must be defined in one test procedure and validated with type approval emissions

NPTI WORKGROUP: 2016 - 2018

- › Informal open PTI workgroup.
- › Goal: Development of PTI emission test procedures.
- › Participants: Researchers, governments, type approval authorities, metrological institutes, test equipment manufacturers, EC-JRC.
- › Exchange of reports and discussions.

- › Chairman: Dr. A. Mayer.

- › From 11/2016 to 06/2016 the NPTI group investigated in six meetings a PTI emission test for DPFs and the specifications of a PTI-PN-tester.

NPTI: PTI-PN RESEARCH ACTIVITIES

1. EC-JRC: Detailed PTI-PN emission research programs in 2017-2018
2. **Germany**: First PTI-PN investigation program was performed in 2018.
3. **Belgium**: First PTI-PN investigation program was performed in 2017, a second program will start in 2018.
4. Switzerland: Detailed PTI-PN emission research programs 2015-2018.
5. **Netherlands**: Detailed PTI-Chassis dyno-PN emission research programs 2013-2019

The PTI PN test results of these five programs are very similar.

Several EU member states investigate the introduction of a PTI-PN-emission test.

2018 PRIORITY: PTI-PN-TESTERS



Potential suppliers of PTI PN testers:

- TSI
- Testo
- Naneos
- Sensors
- AVL
- Dekati
- TEN
-

DUTCH NMI: DRAFT SPECIFICATION OF NEW PTI PN TESTER

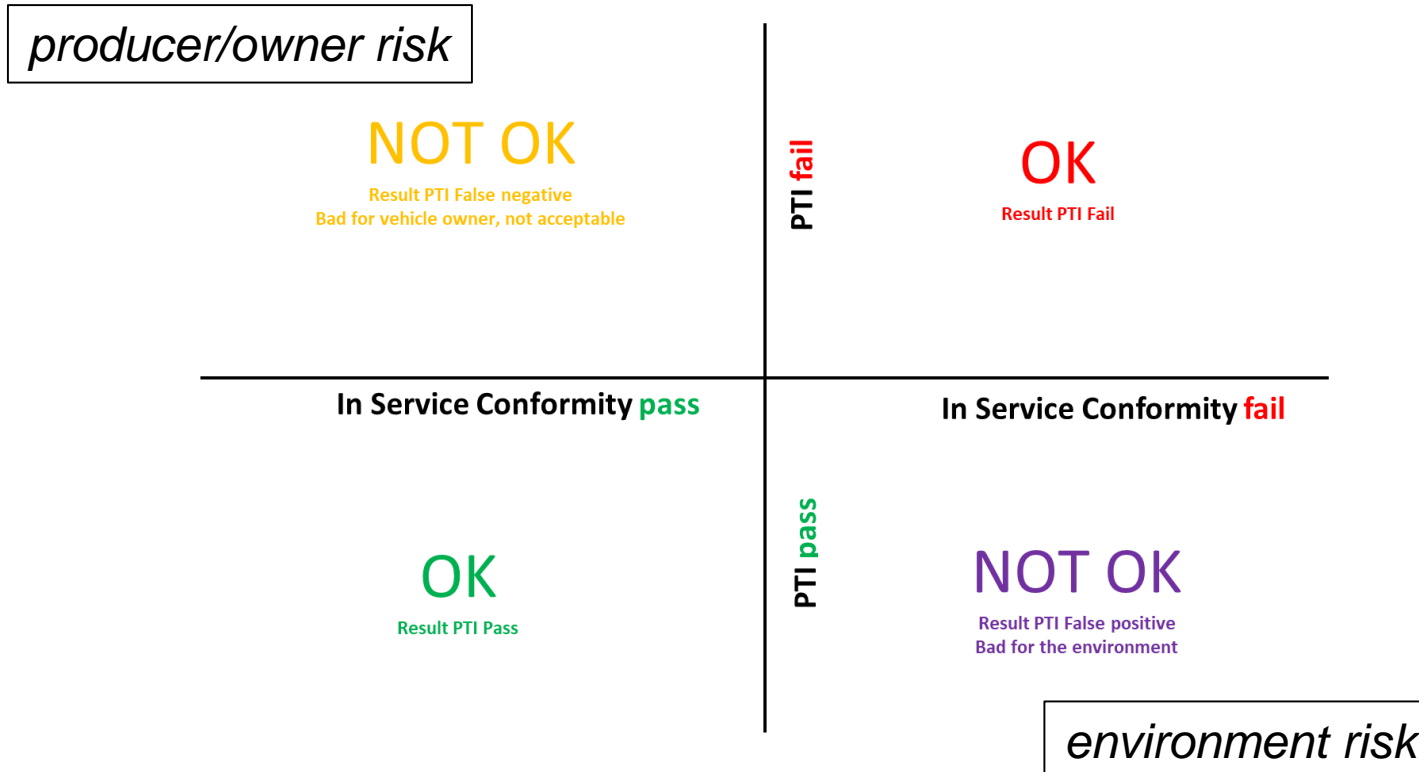
- › Solid Particles, Psize: 70 nm.
- › Measuring range: 0 – 5.000.000 #/cm³.
- › 2018-Q2: Second draft is launched
- › 2018-Q3: Your input is very welcome.
- › 2018-Q4: Dutch specification of a PTI-PN-tester.
- › Contact details: pkok@nmi.nl



DETAILS LOW IDLE SPEED PTI TEST

- › Defined/repeatable engine conditions with the lowest engine PN emission:
 - › Warm engine.
 - › Without Exhaust Gas Recirculation (EGR-valve closed).
 - › Note: EGR can increase the PN-emission 5-10 times!
 - › EGR-systems are often deactivated after 60-180s low idle speed operation.
- › Due to the high filtration efficiency (>99%) of most DPFs at low idle speed 70 to 80% of the vehicles even pass the PTI with an activated EGR-system within 15 seconds.
- › The PN limit value is related to a certain loss of filtration efficiency of the DPF.

RELATIONSHIP OF ISC AND PTI LIMIT VALUES



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

PROPOSAL PTI PN LIMIT VALUES

Euro class	Type Approval & In Service Conformity (Manufacturer)		PTI (Vehicle Owner)
	PM [mg/km]	PN [# /km]	PN [# /cm ³]
3, 4, 5a	5.0	-	1.000.000
5b, 6	4.5	$6 * 10^{11}$	100.000 to 500.000

Note: The engine out PN emission (without EGR) at low idle speed is approximately 2 to 4 E06 #/cm³.



**THANK YOU VERY MUCH FOR
YOUR ATTENTION**

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- › <https://www.tno.nl/en/focus-area/urbanisation/mobility-logistics/clean-mobility/emissions-of-particulate-matter-from-diesel-cars/>



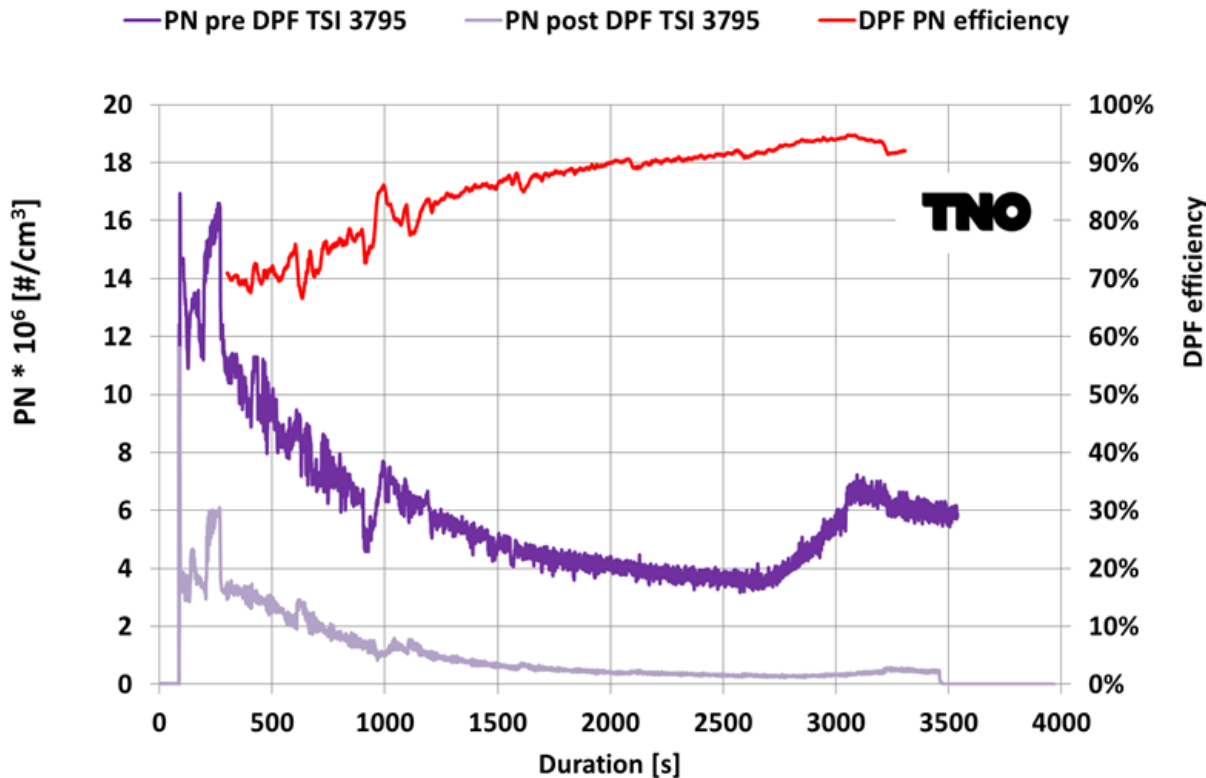
EMISSION LIMIT VALUES

		Type approval, chassis dynamometer				Type Approval & PTI	
		NEDC test 11 km				Free acceleration test	
Emission class	PM limit value	PN limit value			Smoke (Opacity)		
	[mg/km]	[#/km]			k [m ⁻¹]		
Euro 1 – 1993	140	-			3.0		
Euro 2 – 1996	80	-			2.5		
Euro 3 – 2000	50	-			1.5		
Euro 4 – 2005	25	-			0.7		
Euro 5a – 2009	5	-					
Euro 5b – 2011	4.5	6 * 10 ¹¹					
Euro 6 – 2015	4.5	6 * 10 ¹¹					
2018							



EXAMPLE PN EMISSIONS PRE & POST DPF

FORD FIESTA EURO 6: ENGINE START & WARMING UP @ 800 RPM



DPF has a small failure
1 hour @ low idle speed.

At low idle speed the PN emission of the hot engine is
pre DPF 3,600,000 #/cm³
post DPF 300,000 #/cm³.

 2014/45/EC
 PTI smoke: $k = 0.11 \text{ m}^{-1}$.

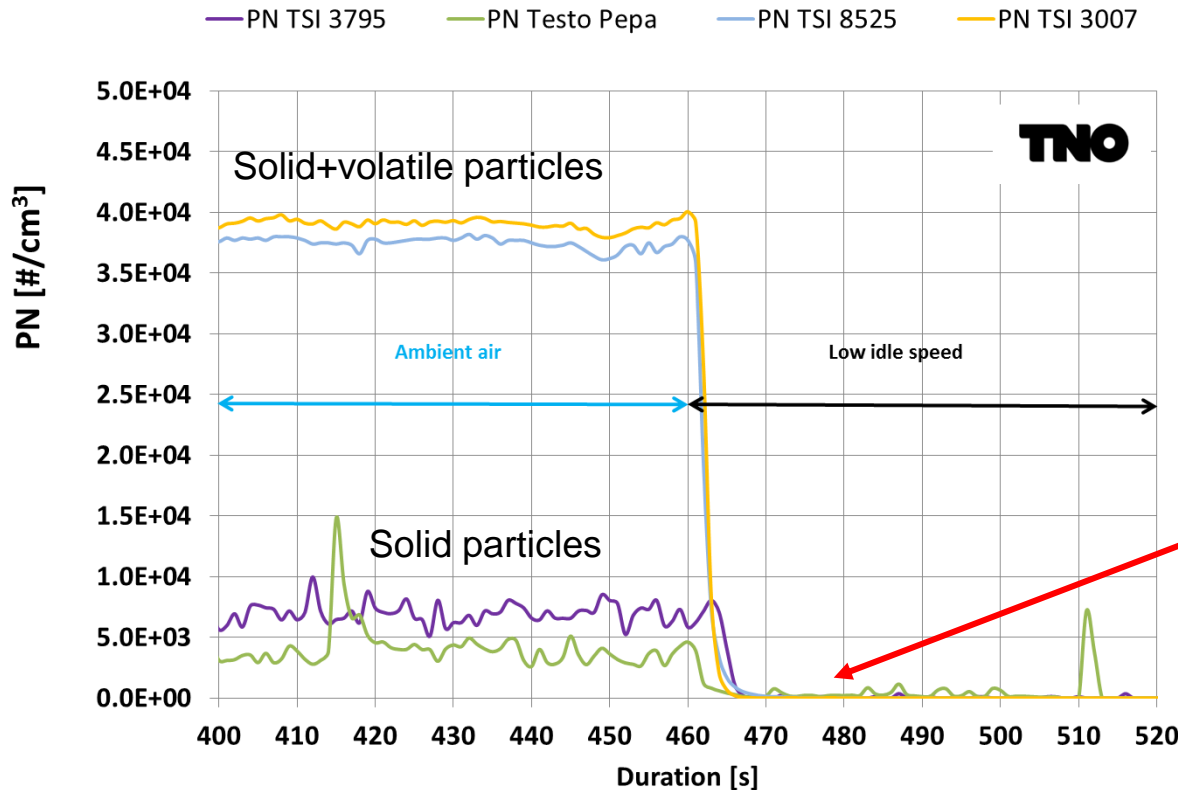
 UNECE R83 Type I test
 Chassis dyno NEDC*:
 PM = 1.5 mg/km (CF = 0.3)
 PN = $3.9 * 10^{12} \text{ #/km}$ (CF = 6.5)

A potential PTI test must be executed with a hot engine.

* Limit values PM=4.5 mg/km, PN $6 * 10^{11} \text{ #/km}$.

IDLE SPEED TEST WITH 4 PN-COUNTERS

PEUGEOT 308 EURO 6 @ 104,755 KM



All PN-testers
measure near zero
#/cm³ with a 'normal'
(= well functioning)
DPF.

Ambient air is cleaned!

No solid & volatile
particle emission at
low idle speed.

Candidate 10 second
PTI test @ low idle
speed