



**testo NanoMet3**

# Periodic Technical Inspection in Mexico City



4.03.2019

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- More than 30 years experience with flue gas analyzers, service and calibration
- Selling more than 20.000 flue gas analyzers p.a.
- Selling more than 12.000 thermal imaging cameras p.a.





## Vehicle Type Approval



### Requirements of Euro 5b

- **Gas Conditioning:**  
Post-Dilution Thermo-Conditioning
- **Particle Counter:**  
Condensation Particle Counter (CPC)

## Real Driving Emissions (RDE)



### Solution for RDE

- **Gas Conditioning:**  
Post-Dilution Thermo-Conditioning
- **Particle Counter:**  
testo Diffusion Charger

## Periodic Technical Inspection



### Solution for PTI

- **Gas Conditioning:**  
Post-Dilution Thermo-Conditioning
- **Particle Counting:**  
testo Diffusion Charger
- Stationary and portable

## Last years of solid particle counting

2011

testo ViPR + CPC

2011 Euro 5b PMP for type approval diesel LDV

2013

testo ViPR + CPC

2013 Euro VI PMP for type approval HDV,

2014

testo NanoMet3

EU requests feasibility study of PEMS-PN for RDE LDV

2015

testo ViPR + CPC

2014 Euro 6 PMP for GDI LDV,

2016

testo ViPR + CPC

EU Stage V proposal of PMP for type approval of NRMM

2017

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2017 RDE – Real Driving Emissions within EURO 6c

2018

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EU feasibility study of PEMS-PN for In-service conformity HDV

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2018 start of PTI in Mexico City

testo ???

2021 start of NPTI in Germany



- January 2017 Dr. Mayer measured in the ambient air in Mexico City with a testo DiSCmini
  - objectively very high number concentrations of nanoparticles and
  - determined, because of the measured particle sizes, the emission of gasoline engines as source.
- March 2017: Dr. Mayer recommended during a workshop in Mexico City to SEDEMA
  - not only to look after diesel engines, but also
  - to measure in detail the particle emissions of gasoline engines, and
  - to introduce the available technology for particle reduction simultaneously with those for diesel engines.
- The following 2 months SEDEMA carried out extensive measurements and planned to equip the Centros de Verificacion with suitable measuring instruments.
- It was not a pure research project, and discussed with SEDEMA that this project should
  - serve to identify High-Emitters of the fleet and
  - it would be possible to implement consistent rules to reduce emissions.

### The challenge:

- bi-annual exhaust gas measurement from July 2018 requires particle number measurement
- 55 testing sites, with a total of 263 testing lanes, are in charge of the PTI exhaust gas measurement of CDMX.
- fleet of 2.4 million gasoline-fueled motor
- performed on a chassis dynamometer with two different loads and
- fully controlled by an Host-PC from the authority

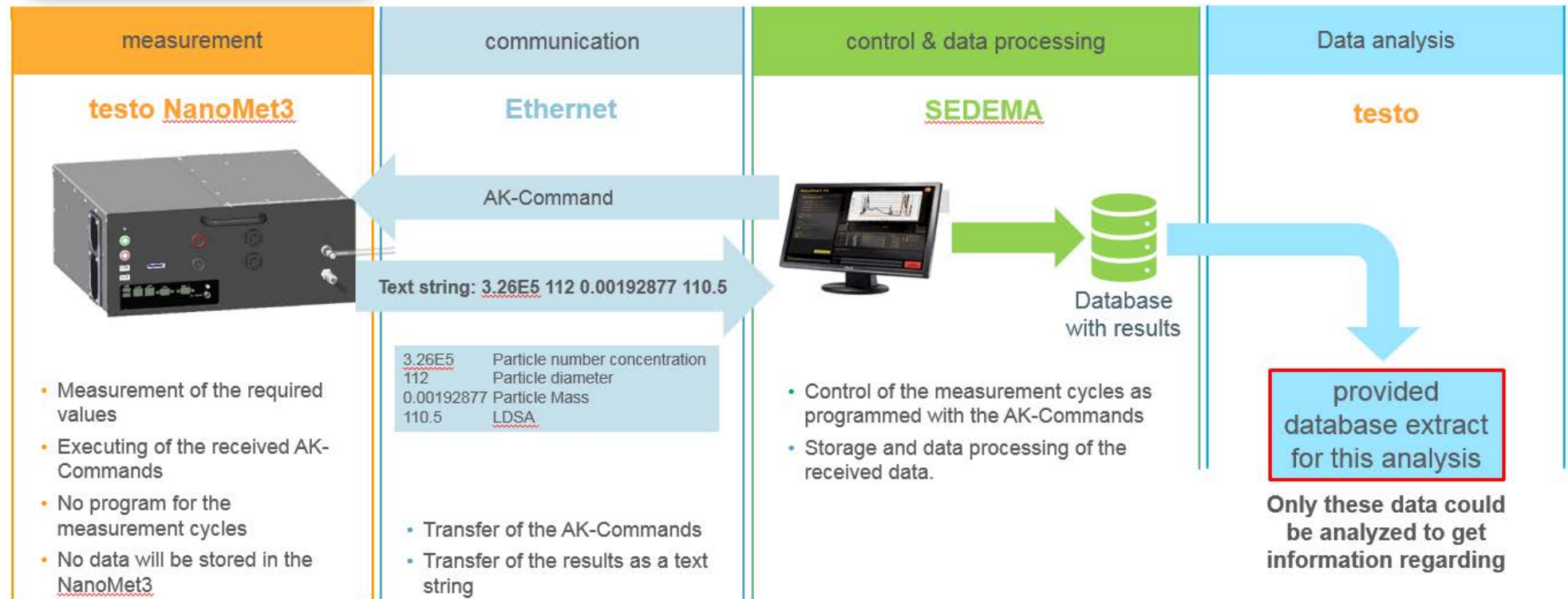


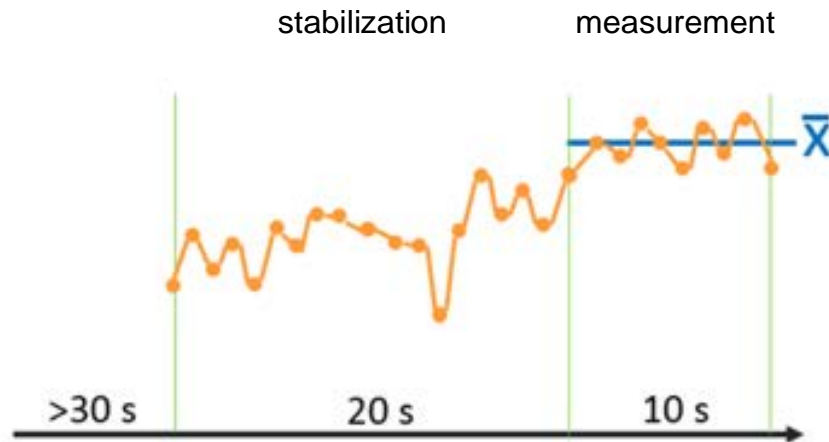
### Testo solution:

- testo NanoMet3 adapted to fulfill the requirements
- 116 lines were equipped with testo nanoparticle technology
- automated and controlled by a Host-PC and linked online to SEDEMA.
- competent support onsite from testo's local partner in CDMX:
  - local service 24/7 and calibration
  - 24 hours response time
  - accredited calibration laboratory in CDMX









Only one value per cycle will be send with the mean value



lower data traffic for each stage



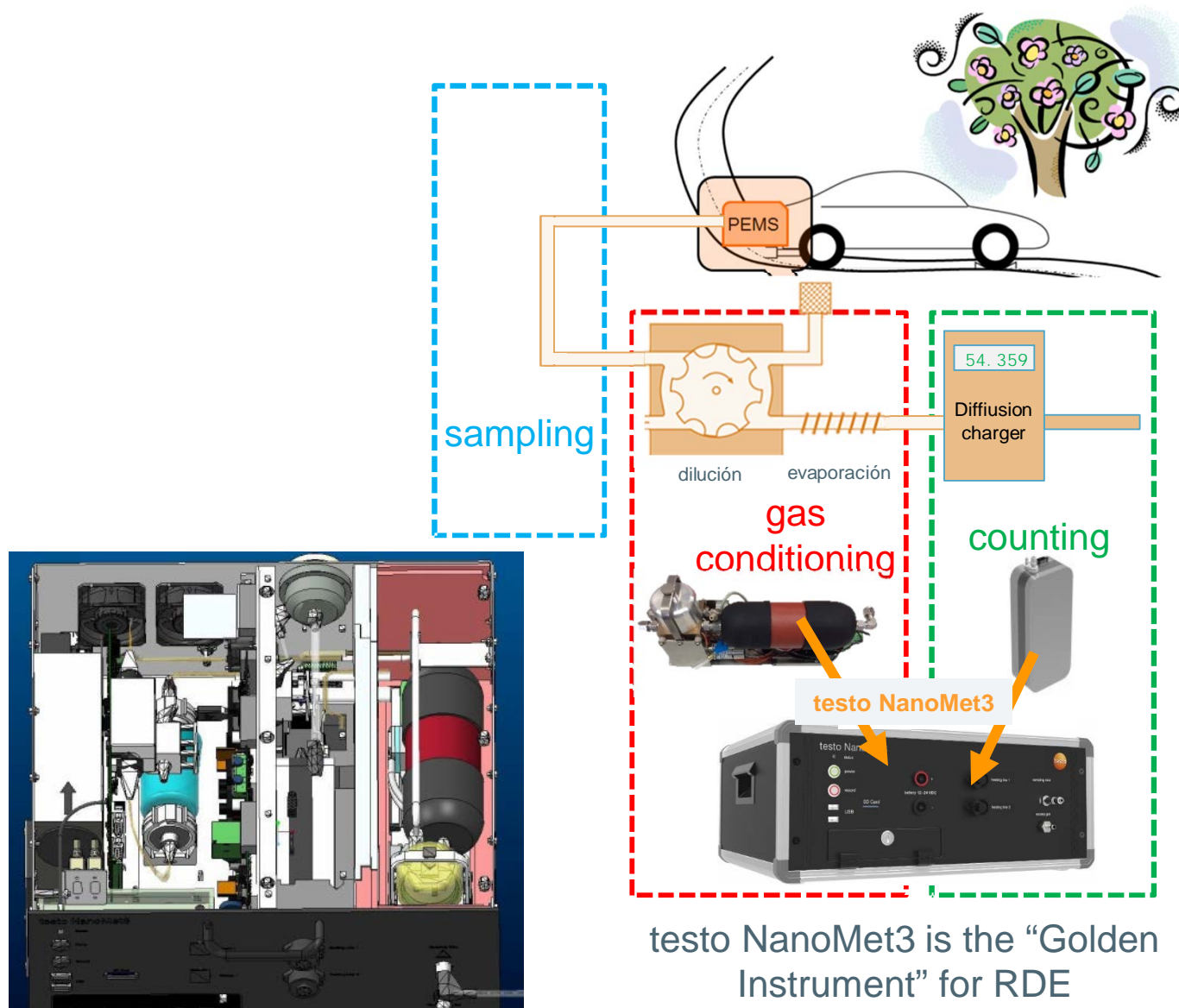
Information if the value is valid or not

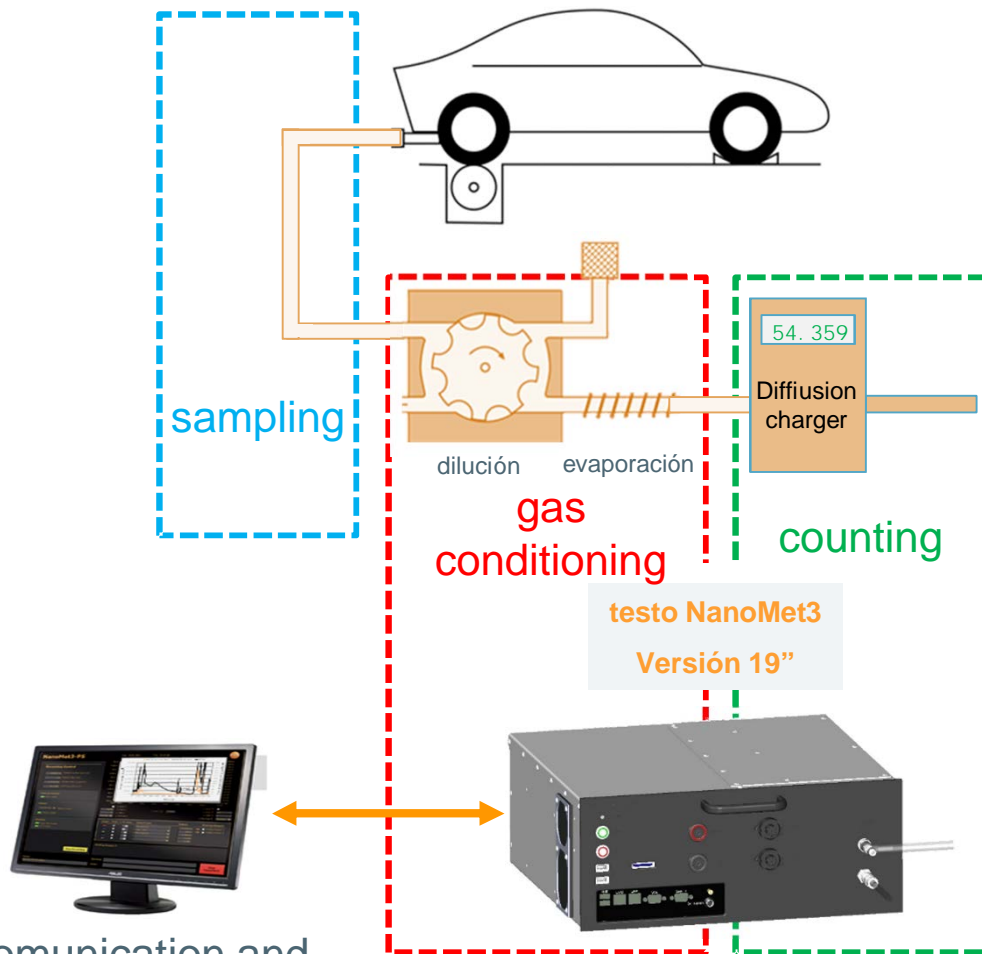


Mean value calculation is already done by the testo NanoMet3

This proposal for the procedure for measuring nanoparticles was in accordance with the Swiss legislation for NRMM (Non Road Mobile Machinery), the only existing reference currently







Communication and control vía host PC to the authority



26 MM (man months) of development and design to make adaptations of

- Case 8
- Mechanical components: 11
- Electronics: 2
- Software: 3
- Metrology and calibration: 4

<b>aerosol</b>	primarily diluted exhaust gases or air which contains nanoparticles
<b>concentration range</b>	sensor: 1E3...1E6 pt/ccm; Diluted: 1E4...3E8pt/ccm
<b>particle size</b>	10...700 nm = 0.01...0.70 µm
<b>average particle size range (mode diameter)</b>	10...300 nm = 0.01...0.30 µm
<b>inlet gas flow</b>	4.0 l/min, actively fed to the diluter by internal pump (STP)
<b>dilution factor</b>	standard: 10, 30, 50, 100, 300. Optional one custom DF
<b>measuring gas</b>	1.0 l/min measuring gas (STP)
<b>power supply</b>	12 -24 VDC, max. 60A. 90 – 240 VAC 50/60 Hz
<b>power consumption</b>	nominal 650W; 300 W under standard ambient conditions
<b>evaporation tube temperatures</b>	ambient...300°C / 572°F; accuracy +/- 3°C/5,4°F
<b>assembly</b>	19" case with handles
<b>weight</b>	approx. 18 kg; with complete connections: ca. 23 kg
<b>operating conditions</b>	T <sub>amb</sub> : 5 ... 35°C; 0...80% relative humidity, max. 80%@30°C, linearly degrading to 50%@35°C, non-condensing
<b>Sensor calibration</b>	standard calibration with NaCl particles
<b>System calibration</b>	against PMP-System with soot from CAST @ GMD 60nm and 85nm





## Status today: Calibration from testo

### Certificate of Conformity

Instrument  
NanoMet3 Sensor SN 101930

Date  
2018-01-26

Engineer  
Mariana Garcia Prince

### Reference Instruments

Classifier 3080 SN 71222085  
DMA 3081 SN 3081122001  
CPC 3775 SN 70748100  
Aerosol NaCl lognormal

Validation of particle number  
CPC 3790 SN 70725185  
Aerosol soot lognormal  
Reference N 8396 Plom<sup>3</sup>  
DISCmini N 8935 Plom<sup>3</sup>  
Deviation N 6%

Validation of particle size  
Reference GMD 70.3 nm  
GSD 1.51  
DISCmini GMD 70 nm  
Deviation GMD 0%

**Conformity**  
We confirm that this Testo product was calibrated under the observation of a DIN EN ISO 9001:2008 certified quality assurance system.  
The measuring installations used for this calibration are calibrated regularly and can be traced back to the national standards of the German Federal Physical and Technical Institution (PTB), or to other national standards, should no national standard exist, the measuring procedure corresponds with the currently valid technical regulations and standards.  
This calibration protocol is proof of adherence to the tolerances as confirmed by us.

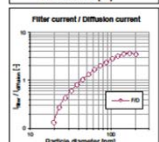
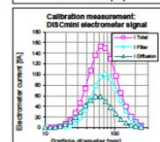
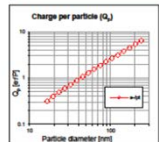
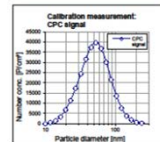
Page 1 of 2

### Certificate of Conformity

Instrument  
DISCmini SN 101930

Date  
2018-01-26

Calibration Constants  
a0 4.24  
a1 38.07  
a2 -9.32  
a3 2.43



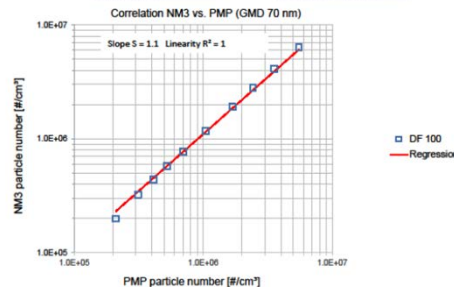
Page 2 of 2

### NanoMet3 vs. PMP Calibration Certificate

Device under Test  
Model NanoMet3  
Serial number 1021103  
DISC sensor DISC  
Sensor SN 101930

Aerosol  
Composition soot  
CAST SN 105007  
Aerosol type polydisperse  
Size (GMD) 66.7  
Width (GSD) 1.41

Reference instruments  
Model CPC TSI 3790  
SN CPC 70725185  
CU-2 101195  
SN MD19-3E 101715  
SN ASET15-1 101726



Engineer  
Mariana Garcia Prince

Signature

Calibration Date  
01 February 2018

Servicios **relativos**  
a las mediciones.



## Coming soon: Calibration in CDMX

- Validation from GIMIM as accredited laboratory from Entidad Mexicana de Acreditación (ema)
- Service executed by a company accredited for several magnitudes.





## Grupo de Instrumentación y Medición Industrial de México



### Accredited Calibration Laboratory for:

- Humidity H-20
- Dew Point H-20
- Temperature T-97
- Reference gases AE-06
- Nanoparticles coming soon

### Calibration ISO for:

- Air velocity
- Pressure
- Flow gas meters

### Customers:



- The GMD is, as expected, at around 50 nm
- With a wide range of options available to improve high-emitting vehicles by:
  - engine maintenance with replacement of air- and fuel filters
  - replacement of the lubricating oil, use of "low ash" lubricating oil, avoidance of excessive oil levels
  - replacement of spark plugs
  - check of the injectors, cleaning or replacement if necessary.and with higher costs:
  - installation of a (available) four-way catalyst as a measure with some increased effort
  - revision of the entire engine
  - scrapping of the vehicle for a bonus for the procurement of a new vehicle

**It is possible to reduce by a 60% the emissions of nanoparticles in CDMX caused by 2% of the vehicles**