



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Institute of Metrology METAS



Nanoparticle measuring instruments for combustion engines

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Metrological regulation

Swiss legal base

- Art. 125 of the federal constitution:
“The legislation on measurement is the duty of the federation.”
- Art. 5 of the federal law on measurements (SR 941.20):
“The federal council of Switzerland decides, which measuring instruments are governed by this law.”
- Art. 3 of the measuring instrument ordinance (SR 941.210)
“A measuring instrument is governed by the ordinance, if it is used for trade and business, human and animal protection, environmental protection, public security or an official establishment of facts and the federal department of justice and police has enacted a measurement instrument specific ordinance.”

Metrological regulation measurement instrument specific ordinance

Prerequisites for issuing a measurement specific ordinance are:

1. Is there a protection requirement?
2. Is there a regulation?

“...measurement instruments must be used, which fulfil the requirements of the measurement instrument ordinance ...”

- **Then and only then, the federal department of justice and police issues a measurement instrument specific ordinance.**

Metrological regulation nanoparticle measurement instruments

1. Today's opacimeters shall be replaced by more sensitive and particle number based measurement instruments for official controls (Art. 13 Ordinance on Air Pollution Control) as well as for emission tests of owners of construction machinery
 2. Art. 14 Para. 2 Ordinance on Air Pollution Control states:
"The technical requirements for measurement systems and measurement stability are those specified in the ordinance of 15 February 2006 on measuring instruments"
- **January 1st 2013 the federal department of justice and police amended the ordinance on exhaust emission measurement instruments (SR 941.242) with nanoparticle measurement instruments (slightly modified March 1st 2014).**

Metrological regulation

Ordinance on exhaust emission measurement instr.

Ordinanza del DFGP
sugli strumenti di misurazione dei gas di scarico
dei motori a combustione
(OSGS)

941.242

Ordonnance du DFJP
del 19 marzo 2006 (Stat) **sur les instruments mesureurs des gaz d'échappement**
des moteurs à combustion¹

941.242

Il Dipartimento federal
visti gli articoli 5 capov
17 capoverso 2, 24 capov
strumenti di misurazione
ordina:

(OIGE)

du 19 mars 2006 (Etat le 1

Verordnung des EJPD
über Abgasmessmittel für Verbrennungsmotoren¹
(VAMV)

941.242

Le Département fédéral de
vu les art. 5, al. 2, 8, al. 2,
de l'ordonnance du 15 fév
sur les instruments de mes
arrête:

vom 19. März 2006 (Stand am 1. März 2014)

Das Eidgenössische Justiz- und Polizeidepartement (EJPD),
gestützt auf die Artikel 5 Absatz 2, 8 Absatz 2, 11 Absatz 2, 16 Absatz 2,
17 Absatz 2, 24 Absatz 3 und 33 der Messmittelverordnung vom 15. Februar 2006²
(Messmittelverordnung),³
verordnet:

Nanoparticle measurement instruments procedures to put on the market

- Art. 9b Ordinance of exhaust emission instruments demands the following conformity evaluation procedure:

pattern approval:
Module B (type examination)

product examination:
Module F (declaration of conformity to type by product verification)

- 2014: only conformity assessment body is METAS-Cert.

CH **M 14** **CH01**



Nanoparticle measurement instruments procedures to maintain measurement stability

Art. 9c Ordinance of exhaust emission instruments demands the following procedures to maintain measurement stability:

1. Yearly maintenance by an experienced person (e.g. manufacturer)
 2. Yearly verification by METAS or an authorized verification office (at the moment only METAS will verify instruments)
- **The instrument user is responsible to follow the procedures to maintain the measurement stability (Art. 21 measurement instruments ordinance)**
 - **For official controls only verified instruments are allowed.**



Nanoparticle measurement instruments metrological requirements I

The following metrological requirements are tested during pattern approval:

- measurement range
at least $5 \times 10^4 \text{ cm}^{-3}$ to $5 \times 10^6 \text{ cm}^{-3}$
indicate results below and above measurement range
measurement results indicated at ambient conditions
- conditions of operation
operate between $-10 \text{ }^\circ\text{C}$ and $+40 \text{ }^\circ\text{C}$;
operate between 860 hPa and 1060 hPa;
withstand vibrations class M2
withstand electromagnetic disturbances class E2



Nanoparticle measurement instruments metrological requirements II

The following metrological requirements are tested during pattern approval:

- error limits

Mobility diameter	Efficiency E
23 nm nanoparticles	$E < 50 \%$
41 nm nanoparticles	$50 \% < E$
80 nm nanoparticles	$70 \% < E < 130 \%$
200 nm nanoparticles	$E < 200 \%$
30 nm liquid tetracontane particles (up to 10^5 cm^{-3})	$E < 5 \%$

→ **PMP-light**

Nanoparticle measurement instruments metrological requirements III

The following metrological requirements are tested during pattern approval:

- disturbances
results have to stay within error limits
or no results has to be indicated
no official measurement shall be allowed
- other requirements
individual effects have to be minimized
response time after steep increase or decrease ≤ 5 s
delay time ≤ 10 s
readable 10 Hz signal for pattern approval
portable use outside



Nanoparticle measurement instruments “official” measurement mode

The “official” measurement mode ensures measurements according to the procedures defined by the Federal Office for the Environments (see presentation of Simone Krähenbühl)

- started and stopped by instrument user
 - not interrupted by instrument user
 - last maximally 5 min
 - calculates weighted mean of measurement values
 - displays actual and mean value and duration
 - stores permanently the term official measurement mode, date and time of the measurement, mean values and duration.
- **Permanent Storage can mean printout or digital document. Original data must be kept unaltered.**



Testing infrastructure at METAS

- Infrastructure for type examination and product examination as well as verification is in place.
- Internal measurement procedures have been validated in an international study of prototype measurement instruments for engines of modern diesel vehicle (see poster of Anke Gehrkens-Jordan).
- We see great interest from manufacturer to develop and test nanoparticle measurement instruments according to the Swiss regulation.
- A first type examination is ongoing. More type examination are expected in the next year.



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Thank you very much