SLOVENSKI STANDARD
oSIST prEN 17507:2020

01-julij-2020

Cestna vozila - Prenosni sistemi za merjenje emisij (PEMS) - Ocenjevanje delovanja

Road Vehicles - Portable Emission Measuring Systems (PEMS) - Performance Assessment

Straßenfahrzeuge - Mobile Abgasmesssysteme (PEMS) - Leistungsbewertung

Véhicules routiers - Systèmes portatifs de mesure des émissions (PEMS) - Vérification de la performance

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ICS:

43.180	Diagnostična, vdrževalna in preskusna oprema	Diagnostic, maintenance and test equipment

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Road Vehicles - Portable Emission Measuring Systems (PEMS) - Performance Assessment

Véhicules routiers - Systèmes portatifs de mesure des émissions (PEMS) - Vérification de la performance

Straßenfahrzeuge - Mobile Abgasmesssysteme (PEMS) - Leistungsbewertung

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 17507:2020) has been prepared by Technical Committee CEN/TC 301 "Road vehicles", the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN enquiry.

Introduction

The intention of this document is to determine the measurement uncertainty of mobile vehicle exhaust emission testing equipment (e.g. Portable Emissions Measurement Systems, PEMS) under consideration of applicable legal requirements.

The specific aims include the following.

— To be able to validate PEMS systems (for gaseous and particle number emissions) under various operating environments with the intention of predicting PEMS performance over the whole range of conditions used. It focusses on light-duty-vehicle application and serves as a basis for assessing the uncertainty of heavy-duty emission measurement equipment.

— To be able to evaluate the deviation of gaseous PEMS under various light-duty RDE test conditions and heavy-duty PEMS test conditions against known analyser systems under standard laboratory conditions for the specified gas, which is traceable to national or international primary standards.

— To be able to evaluate the deviation of Particle Number (PN) - PEMS under various light-duty RDE test conditions and heavy-duty PEMS test conditions against a known analyser system under standard laboratory conditions for the same sample, which is traceable to national or international primary or secondary standards.

— To define the means for demonstrating that the PEMS equipment is stable and the measurement quality is sufficient between PEMS equipment service intervals.

— To provide input to the development of future specifications and quantified information about instrument and process accuracy to help improve the accuracy and robustness of PEMS systems and on-road measurements.

— To set a framework for determining the PEMS measurement uncertainty and the uncertainty of RDE measurements by analysing available data and providing a method for data evaluation.

In particular, the derivation of the uncertainty according to all parts of the document allows the following.

— The instrument measurement uncertainty can be evaluated.

— The RDE measurement uncertainty can be reported as a part of the measurement result following DIN 1319-1:1995.

— The results of an investigation based on this standard provide information about the suitability of the equipment for the intended use and provide a basis for the definition of conformity and non-conformity criteria.

— Transparency with respect to the instrument measurement uncertainty of currently available equipment.

— Transparency with respect to the measurement uncertainty of the testing processes, currently established by vehicle manufacturers, technical services and type approval authorities (e.g. effects of testing routine and route).

— Explanation and assessment of deviant measurement results of repetitive measurements with the same vehicle / vehicle type.

— Explanation and assessment of deviant measurement results of the same vehicle / vehicle type when tested by different parties.

1 Scope

This document defines the procedures for assessing the performance of PEMS equipment, which is used for the on-road measurement of tailpipe emissions of light-duty vehicles, on the basis of a common test procedure that simulates the range of conditions experienced during on-road tests.

This document prescribes:

a) the tests to be conducted, and,

b) a procedure to determine, for any particular piece of PEMS equipment, an appropriate uncertainty margin to reflect its performance over those conditions.

The key test variables are as follows (but not limited to the ones mentioned):

1) temperature, humidity and pressure and step-wise or gradual changes,

2) acceleration and deceleration (longitudinal and lateral),

3) vibration, inclination and shock tests,

4) instrument positioning on a vehicle,

5) combinations of (1) to (4),

6) cross-Interferences,

7) signal-processing, data treatment and time alignment, and

8) calculation methods (excluding the regulatory post-processing of data).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 27891:2015, *Aerosol particle number concentration — Calibration of condensation particle counters*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
inspection decision
result of an inspection

3.1.2
inspection
inspection process
conformity evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging

3.1.3
limit of error
maximum permissible error
extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system

3.1.4
measurement standard
realization of the definition of a given quantity, with stated quantity value and associated measurement uncertainty, used as a reference

3.1.5
measuring and test equipment
device used for making measurements, alone or in conjunction with one or more supplementary devices

3.1.6
measuring system
set of one or more measuring instruments and often other devices, including any reagent and supply, assembled and adapted to give information used to generate measured quantity values within specified intervals for quantities of specified kinds

3.1.7
measurement uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

3.1.8
uncertainty budget
statement of a measurement uncertainty, of the components of that measurement uncertainty, and of their calculation and combination

3.2 Symbols and abbreviations

CLA	Chemiluminescence analyser
CLD	Chemiluminescence detector
PN	Particle Number
EFM	Exhaust flow meter
GMD	Geometric mean mobility diameter
NDIR	Non-dispersive infrared
NDUV	Non-dispersive ultraviolet
PEMS	Portable emission measuring systems
RDE	Real-driving emissions

SOC	State of charge
PSD	Power Spectral Density
GRR	Gauge repeatability reproducability
GUM	Guide to the Expression of Uncertainty in Measurement
k	k-factor
MPE	Maximum Permissible Error
USL	Upper limit of specification
USL_L	limit of detection of legally defined non-compliance
USL_M	limit of detection of legally defined compliance
QMS/MP,Max	Capability limit
QMS/MP	Capability limit
R&R	Repeatability and reproducibility
RE	Resolution (of measurement system)
TOL	Tolerance
uAV	Uncertainty contribution of operator
uBi	Uncertainty contribution of bias
uCAL	Uncertainty contribution of calibration
uEVO	Uncertainty contribution of repeatability at the object
uEVR	Uncertainty contribution of Repeatability on standards
UIAI	Uncertainty contribution of interdependence
uMP	Uncertainty contribution by measurement procedure
UMP	Extended measurement uncertainty contribution by measurement procedure
uMS	Uncertaintly contribution by measurement system
UMS	Extended measurement uncertainty contribution by measurement system
uRE	Uncertainty contribution by resolution
LSL	Lower limit of specification
VDE	
VDI	
VIM	Vocabulary of Metrology (VIM)

4 Proposed document structure including requirements, responsibilities and results

This document is structured according to Table 1. This table also includes recommendations, which party should be responsible to conduct the tests and evaluate the uncertainty following the procedures which are described in this standard.

Table 1 — Document structure

Clause	Requirement	Responsibility	Result
5.1	General requirements [boundary conditions] on PEMS measurement systems [during RDE testing]	--	Defined boundary conditions
5.2	Gaseous analysers [Performance test procedures]	PEMS manufacturers	Proof, that PEMS system component works under defined boundary conditions; boundary conditions defined
5.3	Particle number analysers [Performance test procedures]		
5.4	Exhaust flow meter [Performance test procedures]		
5.5	GPS [Performance test procedures]		
6	Uncertainty assessment of the individual components of PEMS	PEMS manufacturers	Uncertainty contributions for each component
7	Theoretical PEMS measurement uncertainty based on PEMS components	--	
8	Evaluation of uncertainty of performance testing	--	See below
8.1	Overarching descriptions	--	
8.2	RDE measurement process	--	Defined process
8.3	Traceability of mobile exhaust emission measurement systems ▪ Traceability to the national standard ▪ Testing the PEMS against reference gas ▪ Evaluation of the deviation from the defined error limit (MPE: Maximum Permissible Error) ▪ Round robin test If the deviation is sufficiently small, then it can be traced back.	PEMS manufacturers 1st calibration Recalibration	PEMS Acceptance and reverification
8.4	Uncertainty of the measurement equipment (PEMS) in comparison to the measurement process (RDE measurement)	--	Understanding the procedure
8.5	Uncertainty contributions on the inspection process (Ishikawa-Diagram)	--	Defined Uncertainty Contributions
8.6	Uncertainty evaluations	Individual PEMS User	Combined measurement uncertainty of the PEMS validation
8.7	Calculation of the expanded measurement uncertainty	PEMS User Community	Combined measurement uncertainty of the RDE inspection process;

Clause	Requirement	Responsibility	Result
8.7	Calculation of the expanded measurement uncertainty	--	
8.8	Consideration of the measurement uncertainty for the inspection decision	Individual PEMS User	Measurement uncertainty of inspection decision

5 PEMS requirements and equipment

5.1 General requirements

5.1.1 Boundary conditions

PEMS are used in a wide range of conditions. Table 2 below gives the main parameters that should be taken into account with their possible range according to the RDE procedure and their real range of variation during a real test.

Table 2 — Parameters of the boundaries conditions

Boundaries conditions	RDE possible range	real range variation during test
temperature	−7°C to 35°C	+ or −10°C during one test up to −30°C if soaked in a garage
altitude	0 to 1300m	+1200m / 100km as positive altitude gain
pressure variation	850 to 1050 hPa (sea level)	up to ±150 hPa variation during the test
humidity		5 % to 90 % non-condensing relative humidity (RH)
vibrations	See 5.1.5	See 5.1.5
duration of the test	1,5 to 2 h	1,5 to 2 h

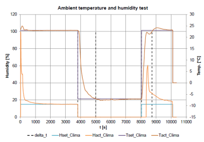
5.1.2 Temperature

During the test, according to the real life, the vehicle can be soaked in a garage at 23°C and go outside with a temperature at −7°C, the direct variation can be up to −30°C.

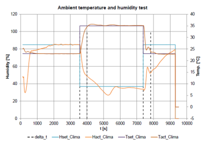
According to extreme atmospheric conditions and fact that the vehicle can climb a mountain, the variation of temperature during the test can be negative (decrease of the temperature at the top of the mountain) and positive (increase of the temperature at the bottom of the mountain).

A variation of −30°C and +12°C shall be considered during a test to check the impact of the measurement accuracy and drift.

Examples of temperatures changes are given in the Figure 1.



a) 23°C to −7°C



b) 23 °C to 35 °C

Figure 1 — Examples of temperatures changes in a climate chamber

NOTE The temperature changes from 23 °C to −7 °C is realized in around 20 min.

5.1.3 Altitude / Pressure

Table 3 shows the variation of pressure (in hPa or mBar) according to the atmospheric condition (vertical variation) and the altitude (horizontal variation).

Table 3 — Variation of pressure in relation to the altitude

	Altitude (m)								
	0	250	500	750	1 000	1 250	1 500	1 750	2 000
Atmospheric pressure (hPa or mBar)	1 050	1022	995	967	935	911	884	851	828
	1 040	1012	985	957	926	901	874	842	818
	1 030	1002	975	947	917	891	864	834	808
	1 020	992	965	937	908	881	854	825	798
	1 010	982	955	927	899	871	844	816	788
	1 000	972	945	917	890	861	834	807	778
	990	962	935	907	881	851	824	798	768
	980	952	925	897	872	841	814	789	758
	970	942	915	887	863	831	804	780	748
	960	932	905	877	854	821	794	771	738
	950	922	895	867	846	811	784	762	728

According to extreme atmospheric conditions and fact that the vehicle can climb a mountain, the variation of pressure during the test can be negative (decrease of the pressure at the top of the mountain up to 1000m) and positive (increase of the pressure at sea level).

A variation of ± 150 hPa shall be considered during a test to check the impact of the measurement accuracy and drift.

5.1.4 Humidity

The range of humidity shall be checked for each pollutant according to the analyser technologies to check the impact (interference, drift, correction). The main variation in term of hygrometry is linked to the exhaust gas humidity concentration for the analyser: during the engine start, condensation could occur in the exhaust pipe line and exhaust gases are also dry and becomes humid when the exhaust line temperature increases. The analysers may also measure in a wide range of humidity conditions.

5.1.5 Vibration

5.1.5.1 Vibration tests

5.1.5.1.1 General

Vibration testing of gaseous analysers will be performed in a laboratory using a vibration table that is appropriate for the mass of the complete PEMS system. The vibration excitation will be applied at the mounting point of the PEMS system, whether that is internal or external to the vehicle. A 30-min random vibration test will be performed according to the conditions of Table 4 at 0,5 G_{rms} acceleration in the Z (vertical) direction while measuring zero gas. This profile is an adaptation of ISO 16750-3 Test IV, which was designed as an accelerated durability test for components on passenger vehicles operating on a variety of road conditions. For the purpose of determining PEMS vibration insensitivity, only the first three break points are used (from 10 Hz to 180 Hz), and the acceleration is lowered to 0,5 G_{rms}. This test may be performed in conjunction with the vibration test of the particulate analyser.

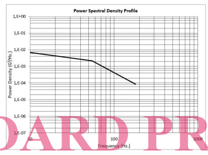


Figure 2 — Power spectral density (PSD) profile

Table 4 — Values for PSD and frequency

Frequency (Hz)	PSD (G^2/Hz)
10	6.73E-03
55	2.19E-03
180	8.42E-05

5.1.6 PEMS battery voltage test

5.1.6.1 General

Two methods are proposed to test the PEMS battery voltage.

The aim is to determine the analyser response variation with respect to variation in power supply voltage alone, minimizing the potential analyser response variation due to variation in the concentration produced by the Particle Generator Unit or by uncontrollable variations in ambient conditions over the longer time period of the RDE test (120 min). Therefore, the maximum duration of these checks shall not exceed 30 min.

5.1.6.2 Method A: Using a Power Supply Unit (PSU) with a Controllable Voltage

Zero drift:

— Ensure stable environmental conditions.