United Nations ECE/TRANS/WP.29/GRPE/2023/9

Economic and Social Council

Distr.: General
27 October 2022

Original: English

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations

Working Party on Pollution and Energy

Eighty-seventh session
Geneva, 10-13 January 2023
Item 13. of the provisional agenda
Lifetime compliance

Proposal for an amendment to Resolution R.E.6 on test-equipment, skills and training of inspectors, supervision

Submitted by the Informal Working Group on Periodical Technical Inspections (PTI)*

The text reproduced below was prepared by the Informal Working Group on Periodical Technical Inspections (PTI). This document proposes to add the possibility to perform a particle number (PN) test on diesel cars of categories M and N into Resolution R.E.6.

* In accordance with the programme of work of the Inland Transport Committee for 2023 as outlined in proposed programme budget for 2023 (A/77/6 (Sect. 20), table 20.6), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Insert a new paragraph 3.1.17., to read:

"3.1.17. A device for measuring the particle number concentration with sufficient accuracy."

Insert a new paragraph 7., to read:

"7. Minimum requirements for checking the presence and proper working of diesel particulate filters

The presence and proper working of a Diesel Particulate Filter (DPF) is checked in a periodic technical inspection with a particle counter which measures the particle number concentration of an exhaust gas sample.

7.1 Minimum requirements concerning the particle counter:

7.1.1. A sampling system that transports representative exhaust gas from the tailpipe to the particle number counter and meets certain criteria for particle losses;

7.1.2. A measuring system to avoid particle losses caused by condensed matter (such as water or fuel);

7.1.3. A system that removes a defined minimum share of volatile particles from the sample;

7.1.4. A system for determination of the volumetric concentration of particles in an exhaust gas sample. The system measures solid particles of a defined mobility size diameter range. The measuring unit is particles per cubic centimeter (#/cm^3);

7.1.5. A measuring range with a specified measuring accuracy around the emission limit value(s) for determination of the particle number concentration. An extended measuring range (with reduced measuring accuracy) is needed for diagnostic purposes;

7.1.6. A processor that can be freely set on the following points of a programmable test procedure: stabilisation times, sampling times, sampling numbers and sampling frequency;

7.1.7. A display with actual information of the measuring procedure and the actual measured particle number concentration;

7.1.8. A leak check facility or procedure;

7.1.9. An adjustment facility for calibration and recertification purposes;

7.1.10. A diagnosis system to ensure the proper working of the particle counter;

Minimum metrological requirements of a particle counter are described in paragraph 7.4.

7.2. Minimum requirements concerning the emission test:

7.2.1. PN-emission test:

The PN-emission test is executed at low idle speed;

7.2.2. Engine preconditioning:

In order to reach stable engine emissions engine preconditioning is needed.

Minimum and stable PN emission can be achieved under the following conditions:

(a) Engine at operating temperature (coolant > 60 °C or according to recommendations of the manufacturer).

(b) Stable EGR-system(s), this can be checked through OBD.

(c) No DPF regeneration, this can be checked through exhaust gas temperature.

7.2.3. Test and measuring procedure:

After the particle tester has warmed up and a leak check has been carried out, the test procedure is started. Representative exhaust gas is sampled from the exhaust pipe and fed into the emissions tester. After a stabilization time as defined in paragraph 7.4.10, the measurement is started and the particle concentration is measured during at least 15 seconds. Finally the average particle concentration over the measurement time is determined;

7.2.4. Determination of the average test result:

The average arithmetic particle concentration of the collected instantaneous measured values is determined by a microprocessor on the basis of the measurement time and minimum measurement frequency. In case of multiple measurements, for every measurement the average particle concentration is determined. Finally the arithmetic mean of the various measurements is determined.

7.3 Minimum requirements concerning the PN emission limit values:

7.3.1. PN limit values

The recommended limit value of the particle number concentration is between 250,000 and 1.000.000 #/cm^3 depending on which goal is pursued:

(a) When detection of DPF removal is targeted a PN limit value of 1.000.000 #/cm^3 is suitable.

(b) When checking the DPF filtration efficiency is targeted a PN limit value of 250.000 #/cm^3 is suitable.

In the current emission test procedures at chassis or engine dynamometer a PN limit value of 6.0 * 10^{11} #/km or #/kWh is applied; No PN test at low idle speed with a particle number concentration in #/cm^3 is applied. In order to avoid false negative PTI test results, the PTI-PN limit value should be less strict than the effective PN limit value[1] in the (vehicle or engine) type approval test procedure.

7.3.2. Fast pass option

The option for a fast pass limit value (i.e. 25% of the PN limit value) in longer test procedures will generally lead to shorter test times on average.

7.3.3. Fast fail option

The option for a fast fail limit value is intended to prevent contamination of particle counters. It also leads to shorter test time.

7.4 Minimum metrological requirements regarding particle number counters

7.4.1 Particle Counter:

PTI particle counters measure the volumetric particle concentration of raw exhaust gas. The measuring unit is particles per cubic centimeter (#/cm^3);

7.4.2 Measurement principles:

No requirements are imposed on the measuring principle of the particle counter. To date, particle counters with Diffusion Charging (DC)

[1] Former research of TNO and DG-JRC indicated that a PTI PN value of 50,000 #/cm3 is in line with a chassis dynamometer PN value of 6.0 * 1011 #/km.

technology or Condensation Particle Counter (CPC) technology are designed;

7.4.3 Removal of volatile particles:

At least 90% of the volatile particles are removed from the exhaust gas sample;

7.4.4 Particle sizes:

The particle number counter is characterized with a monodisperse sample with the next two particle sizes:

(a) 23 nm +/- 5%

(b) 80 nm +/- 5%

7.4.5 Counting efficiency ranges:

The required counting efficiency ranges are

(a) 23 nm (+/- 5%) 0.2 – 0.6

(b) 80 nm (+/- 5%) 0.7 – 1.3

7.4.6 Measuring range

The minimum required measuring range shall be from 5,000 #/cm3 to the applicable PTI-PN limit value (between 250,000 and 1,000,000 #/cm^3). For diagnostic purposes, an extension of the measuring range is recommended (between 5,000,000 and 50,000,000 #/cm^3);

7.4.7 Resolution of indication

The least significant figure of the display shall provide a minimum resolution of 1,000 particles/cm^3;

7.4.8 Size of indication

Digital figures of the display shall be at least 5 mm high;

7.4.9 Measuring frequency

The minimum required measuring frequency is 1 Hz;

7.4.10 Processor of the test procedure and data:

The processor of the particle counter is able to apply a minimum stabilisation time of 15 seconds and a minimum measuring time of 15 seconds. The data processor is capable of determining an average measured value from a collection of individual measured values.

7.4.11 Permissible error

The maximum permissible error (Absolute or relative, whichever is greater) of the particle counter is:

(a) Absolute +/- 25,000 #/cm^3

(b) Relative +/- 25%

7.4.12 Repeatability

For 20 consecutive measurements of the same reference PN sample carried out by the same person with the same instrument within relatively short time intervals, the experimental standard deviation of the 20 results shall not be greater than one third of the modulus of the maximum permissible error for the relevant sample.

7.4.13 Stability with time or drift

When used in accordance with the manufacturer's operating instructions, the measurements made by the instrument, under stable environmental

conditions and after adjustment using a reference PN sample or the internal adjustment facility, shall remain within the maximum permissible error for at least 12 h without the need for reference PN sample or internal readjustments by the user. If the instrument is equipped with a means for drift compensation, such as automatic zero or automatic internal adjustment, the action of these adjustments shall not produce an indication that can be confused with a measurement of an external gas.

7.4.14 Response time emission tester

For measuring PN concentration, the instrument including the specified gas handling system shall indicate 95 % of the final value (as determined with reference PN samples) within 15 s after changing from ambient air. The instrument may be provided with a logging device to check this requirement.

7.4.15 Operating conditions

The particle counter ambient operating conditions are:

(a) Temperature: +5 to +40 °C

(b) Pressure: 860 to 1060 hPa

(c) Humidity: up to 95% condensing (open location)

7.4.16 Disturbances

Disturbance tests are part of the type approval of the particle counter. Disturbance parameters are: Shock, vibration, EMC, humidity, main voltage

7.4.17 Calibration

The particle counter should be calibrated at least once every 12 months."

II. Justification

1. The proper working of a diesel particulate filter cannot be determined in the PTI with an opacity test because opacimeters have a lack of sensitivity and are not able to measure low particulate emissions. In order to measure low particulate emissions (near to zero) low cost particle counters were developed and these are now commercially available.

2. In daily use some diesel particulate filters fail or are removed. The particulate emissions of these vehicles raise dramatically and cause adverse health effects of human beings.

3. The measured PN-concentrations in the proposed low idle speed test are representative because they correlate reasonably well with PN emissions in chassis dynamometer tests.