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Measurement methods for noise emitted by light-duty vehicles in multiple driving mode conditions

轻型汽车多工况行驶车外噪声测量方法

(ECE Regulation No.51, Revision 3, 2016, Uniform provisions concerning the approval of motor vehicles having at least four wheels with regard to their sound emissions, NEQ)

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1 Scope

This Standard specifies measuring instruments, measurement conditions, test requirements for measurement methods for noise emitted by light-duty vehicles in multiple driving mode conditions.

This Standard is applicable to measurement of noise emitted by M_1 category, M_2 category and N_1 category vehicles with the maximum design total mass not exceeding 3500kg in multiple driving mode conditions.

2 Normative references

The following referenced documents are indispensable for the application 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.

GB/T 3730.2, *Road vehicle. Masses. Vocabulary and codes*

GB/T 3785.1, *Electroacoustics - Sound level meters - Part 1: Specifications*

GB/T 6326, *Tyre terms and definitions*

GB/T 12534, *Motor vehicles. General rules of road test method*

GB/T 15089, *Classification of power-driven vehicles and trailers*

GB/T 15173, *Electroacoustics - Sound calibrators*

GB/T 19596, *Terminology of electric vehicles*

GB/T 38146.1, *China automotive test cycle - Part 1: Light-duty vehicles*

GB/T 40625-2021, *Indoor measurement methods for noise emitted by accelerating motor vehicles*

ISO 10844, *Acoustics - Specification of test tracks for measuring noise emitted by road vehicles and their tyres*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 3730.2, GB/T 6326, GB/T 15089, GB/T 19596, GB/T 38146 as well as the followings apply.

3.1 test mass of vehicle; m_t

the mass that the curb weight of the whole vehicle plus the weight of 75kg

3.2 total power of vehicle; P_n

the total power of the power source directly involved in the driving of the vehicle

NOTE: The maximum net power of an automobile engine measured according to GB/T 17692, in kilowatts (kW). In electric vehicles, the total power of pure electric vehicles refers to the sum of the peak power of all drive motors measured according to GB/T 18488.2. The total power of a hybrid electric vehicle refers to the sum of the maximum net power of the engine measured according to GB/T 17692 and the peak power of the drive motor measured according to GB/T 18488.2. The total power of fuel cell vehicles refers to the peak power of the drive motor measured according to GB/T 24554, in kilowatts (kW).

3.3 power to mass ratio index; PMR

the ratio of the total power of the vehicle to the test mass of the vehicle

$$PMR = (P_n/m_t) \times 1000$$

NOTE: The unit of power to mass ratio index is expressed in kilowatts per ton (kW/t).

3.4 reference point

the positioning point used to represent the vehicle's position when the test vehicle performs noise measurement

NOTE 1: For a test vehicle with a front engine (drive motor), the reference point is the foremost point of the test vehicle. For a test vehicle with a mid-mounted engine (drive motor), the reference point is the center point of the test vehicle in the front and rear direction. For a test vehicle with a rear engine (drive motor), the reference point is the last end point of the test vehicle.

NOTE 2: For electric test vehicles, consider the position of the main drive motor, and determine the reference point position of the test vehicle according to the above rules. If there are multiple drive motors with equal power, the position of the frontmost drive motor shall prevail.

3.5 test acceleration; a_{test}

the average change in vehicle speed during the acceleration noise test using the specified gear

3.6 number of gears; X

the total number of forward gears of the test vehicle that can lock the transmission ratio (including the transmission ratio obtained by the auxiliary transmission or the multi-speed drive axle)

3.7 exhaust system modes

the mode that, through automatic or manual selection by the driver, it changes the direction of airflow and/or the muffling structure in the exhaust system to produce different noise reduction effects

4 Measurement instruments

4.1 Acoustic measuring instrument

The sound level meter or other equivalent measuring system used for measurement shall meet the requirements of the level 1 sound level meter specified in GB/T 3785.1 (if applicable, windshield shall also be included). When measuring, the "F" time weighting characteristics and "A" frequency weighting characteristics of the sound level meter shall be used. When the sound level meter or measuring system used can automatically sample and measure the "A" weighted sound level, the reading interval shall not exceed 30ms.

4.2 Acoustic measuring instrument calibration

Before and after the measurement, it shall use a level 1 sound calibrator that is in accordance with GB/T 15173 to calibrate. Without making any further adjustments, if the difference between the last calibration reading and the previous calibration reading exceeds 0.5dB(A), the measurement result after the previous calibration is judged to be invalid.

4.3 Other measuring instruments

The measuring instrument shall include the following equipment. The accuracy shall meet the following requirements:

a) Rotational speed measuring instrument, ±2%;

b) Vehicle speed measuring instrument, ±0.5%;

c) Thermometer, ±1°C;

d) Anemometer, ±1.0m/s;

6 Noise test

6.1 General requirements

During the measurement, the test vehicle is close to the CC' line (longitudinal centerline), and the engine speed n_{max} (if applicable) shall not exceed 80% of the rated speed.

For test vehicles with different driving modes (such as sports mode, economy mode and adaptive mode, and so on), the driving mode can be selected. The drive system of the test vehicle shall adopt the driving mode commonly used in normal road driving.

For a test vehicle equipped with a multi-mode exhaust system that can be manually selected, all exhaust system modes shall be tested as specified in 6.2.

6.2 Test items

6.2.1 Accelerated noise test

6.2.1.1 Speed conditions and acceleration range

According to the requirements of GB/T 38146.1, the speed ($v_{PP'}$) from the reference point to line PP' shall be: 30km/h±1km/h, 50km/h±1km/h, 70km/h±2km/h.

The test acceleration a_{est} shall meet the following requirements:

a) When $v_{PP'}$=30km/h±1km/h, 0.5m/s^2≤a_{test}≤3.5m/s^2;

b) When $v_{PP'}$=50km/h±1km/h, 0.5m/s^2≤a_{test}≤3.0m/s^2;

c) When $v_{PP'}$=70km/h±2km/h, 0.3m/s^2≤a_{test}≤2.5m/s^2.

6.2.1.2 Gear selection

6.2.1.2.1 Test vehicle that can lock the transmission ratio

The gear shall meet the following requirements:

a) When $v_{PP'}$=30km/h±1km/h, the gear shall be (1+X/2)/2+1. If it is not an integer, it shall be rounded down;

b) When $v_{PP'}$=50km/h±1km/h, the gear shall be 1+X/2. If it is not an integer, it shall be rounded down;

c) When $v_{PP'}$=70km/h±2km/h, the gear shall be (X/2+X)/2+1. If it is not an integer, it shall be rounded down.

b) For M1 vehicles with PMR≥90kW/t, two additional measurements are allowed on the basis of a). The measured test acceleration difference shall not be greater than 0.3m/s^2. The difference between the average acceleration of this test and the average of a) shall be greater than 0.5m/s^2;

c) When the test vehicle enters line AA' or the previous pre-acceleration position point, quickly depress the accelerator pedal to a suitable position and keep it stable. Release the pedal until the end of the test vehicle passes line BB'. Record $v_{AA'}$, $v_{PP'}$ and $v_{BB'}$ and perform test acceleration calculation;

d) Record the maximum sound pressure level of the test vehicle each time it passes through the measurement area. The difference between the two maximum sound pressure levels on the same side shall not be greater than 2dB(A). Take arithmetic average of the two maximum sound pressure levels on each side. Take the larger of the averages on both sides as the final result.

6.2.2 Constant speed noise test

6.2.2.1 Vehicle speed conditions

According to the requirements of GB/T 38146.1, M_1 category: 80km/h±2km/h, 110km/h±2km/h; N_1 category and M_2 category (maximum design total mass ≤3500kg): 80km/h±2km/h, 90km/h±2km/h.

NOTE: Multi-purpose vans with PMR<90kW/t and meeting GB/T 36881-2018, 3.1 can also refer to the speed conditions of N_1 and M_2 (maximum design total mass ≤3500kg).

6.2.2.2 Gear selection

The test vehicle that can lock the transmission ratio shall be in the highest gear that can drive stably.

For test vehicles that cannot lock the transmission ratio, the gear selector shall be placed in the fully automatic control position.

6.2.2.3 Test methods

The constant noise test is carried out in accordance with the following rules:

a) Separately perform two measurements under each vehicle speed condition specified in 6.2.2.1. The test vehicle shall maintain a constant speed from entering line AA' to passing line BB' at the rear end. Record $v_{AA'}$, $v_{PP'}$ and $v_{BB'}$;

b) Record the maximum sound pressure level of the test vehicle each time it passes through the measurement area. The difference between the two

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