

TCVN 7881:2008

(Second edition)

**Road vehicles - Noise emitted from motorcycles
Requirements and test methods in type approval**

HANOI - 2008

Forewords

TCVN 7881:2008 is completed basing on technical regulations ECE41-02, ECE 41-03, ECE 09-06C1, ECE 09-06S1 and Chapter 9 of 97/24/EC

TCVN 7881: 2008 replaces requirements for motorcycle stated in TCVN 5948:1999, TCVN 6435:1998 and TCVN 6552:1999;

TCVN 7881:2008 was prepared by Technology Committee TCVN/TC22 Road Vehicles, proposed by Directorate for Standards, Metrology and Quality (STAMEQ), and approved by Ministry of Science and Technology.

Road Vehicles - Noise emitted from motorcycles - Requirements and test methods in type approval

1. Scope

This standard specifies requirements and test methods for noise in type approval for two-wheeled and three-wheeled vehicles which are defined in TCVN 6211 (motorcycle is hereby referred as vehicle).

2. Normative documents

Following normative documents are very necessary for application of the standard. For normative documents stated with issuing year, stated version is applied. For normative documents not stated with issuing year, latest version (including changes/amendments) is applied.

TCVN 6211 (ISO 3833) - Road Vehicles – Types – Terms and Conditions

TCVN 7803 (ISO 2599) - Iron ores. Determination of phosphorus content. Titri-metric method

ISO 3310-1 Test sieves -- Technical requirements and testing -- Part 1: Test sieves of metal wire cloth

ISO 10534-1 -Acoustics -- Determination of sound absorption coefficient and impedance in impedance tubes -- Part 1: Method using standing wave ratio

ISO 10534-2 -Acoustics -- Determination of sound absorption coefficient and impedance in impedance tubes – Part 2: Transfer-function method

ISO 10844 - Acoustics – Test surface for road vehicle noise measurement

3. Terms and definitions

Terms used in this standard are defined as follows:

3.1. Approval of a motorcycle

Approval of a type of motorcycle in term of noise; for three-wheel vehicles, this term also include approval of initial exhaust system as an independent technical equipment.

3.2. Motorcycle type

One type of vehicle of which motorcycles have typical characteristic related to noise and emitted system as follows:

3.2.1. Engine type (two-stroke or four-stroke, transitive piston or rotating piston...; number and capacity of cylinders; number of carburetor or fuel injection system; arrangement of valves; maximum output and relevant engine speed (r/min)...

For rotating piston, cylinder capacity should be measured as twice as volume of combustion chamber.

3.2.2. Power transmission system, especially number and transmission ratio of gears.

3.2.3. Number, type and arrangement of exhaust system.

3.2.4. Besides, three-wheeled vehicles should have following characteristics:

3.2.4.1. Shape and material for vehicle body (especially for engine chamber and its noise-insulation material)

3.2.4.2. Length and width of vehicle.

3.3. Exhaust or silencing system

An adequate group of indispensable parts to limit noise due to vehicle and vehicle's exhausted gas.

3.3.1. Original exhaust system or silencing system

System of a type installed for vehicle when approving type or expanding type approval. It can be original system or replaced system.

3.3.2. Non-original exhaust system or silencing system

System of a type which is not installed for vehicle when approving type for expanding type approval. It can only be replaced system.

3.4. Exhaust or silencing systems of different types

Different exhaust or silencing systems with following typical characteristics:

3.4.1. Parts with commercial name or different brand.

3.4.2. Properties of material forming a part are different or parts differs in shapes or dimensions.

3.4.3. Operation theory of at least one part is different.

3.4.4. Their parts are differently installed.

3.5. Exhaust system component

Individual components of which installation forms an exhaust system (such as exhaust pipe, silencing set, for three-wheeled vehicle this can be injection contributor pipe, expansion chamber and injection system (air filter), if any.

If engine should be equipped with injection system (air filter and/or absorber for noise caused by injected air) to be suitable to regulations on noise limitation, then the filter and/or the absorber should be considered to be essential components as exhaust system.

4. Technical documents and test sample

4.1. Technical documents

4.1.1. Document describes vehicle type with characteristics stated in 3.2. Number and/or symbol for recognizing engine type and vehicle type should be stated.

4.1.2. List of components of silencing system. These components should be recognizable.

4.1.3. Installation chart of silencing system which states its position on the vehicle.

4.1.4. Detail chart of each component for easy positioning and recognizing components and material used.

4.2. Sample test

4.2.1. A vehicle representing for that type.

4.2.2. An additional sample of exhaust system or silencing system (not including the sample on the vehicle).

5. Technical requirements

5.1. General requirement

5.1.1. For two-wheeled vehicle: It is required to have following information at identifiable position but not required to have them recognized at the first glare:

a) Name of manufacturer

b) Value of noise (dB(A)) recorded during test for noise of static vehicle under requirements in 5.2.1.1

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c) Engine speed equal to $3/4S$ if S is not greater than 5000 r/min, or equal to $1/2 S$ if S is greater than 5000r/min.

5.1.2. For three-wheeled vehicle

5.1.2.1. Vehicle, engine and exhaust system or silencing system should be designed, manufactured and installed in such a way that the vehicle meets all requirements in this standard in normal working condition even though it can be influenced by vibration.

5.1.2.2. Exhaust system or silencing system should be designed, manufactured and installed to be able to bear erosive influence during working procedure.

5.2. Requirement for noise

5.2.1. Measuring method

5.2.1.1. Noise of vehicle should be measured by two methods, in moving condition and static condition¹⁾ which are stated in Appendix A of this standard, part 1 for two-wheeled vehicle and part II for three-wheeled vehicle.

5.2.1.2. Two measured values under regulations in 5.2.1.1 should be stated in test report under following presentation mode:

Noise:

Moving vehicle.....dB(A) at static velocity

Before acceleration.....km/h, engine speed.....r/min

Static vehicledB(A) with engine speed of.....r/min

5.2.2. Noise limitation

Noise of moving vehicle measured by two methods stated in A.1 for two-wheeled vehicle and in A.3 for three-wheeled vehicle in Appendix A should not be greater than noise limitation specified for types of vehicle and silencing systems stated in Table 1.

Table 1 - Values of noise limit

Types of vehicle	Cylinder volume, C (cm ³)		Value of noise limitation (dB(A))	
	Two-wheeled vehicle	Three-wheeled vehicle	Two-wheeled vehicle	Three-wheeled vehicle
Type I	$C \leq 80$	$C \leq 250$	75	80
Type II	$80 < C \leq 175$	$250 < C \leq 500$	77	
Type III	$C > 175$	$C > 500$	80	

5.3. Additional requirements for silencing system or components containing fiber material

1) Testing method when vehicle does not move to provide referenced value for authority using this method to test noise for circulating vehicles.

5.3.1. For vehicles having equipments which are designed for reducing the noise of exhausted air (silencing system), it is required to apply requirements in Appendix C. If inlet of engine is equipped with air filter and/or absorber in which the absorber is required to ensure compliance with allowable noise, then the air filter and/or the absorber should be considered as components of the silencing system and they should also apply requirements in Appendix C.

5.3.2. Diagram and horizontal cross plane with dimensions of exhaust system should be attached with certification of type approval.

5.3.3. Silencing system should be labeled with clear instruction, readable and non-erasable for label and type information.

6. Compliance of production

6.1. Any vehicle belonging to the type approved and produced in compliance with the type approved by this standard should be equipped with silencing system which is of the type approved with the vehicle and should meet all requirements in article 5.

6.2. To check out the compliance with above requirement, it is required to randomly select one vehicle sample from the production lot of the type approved. The final product is considered to be in compliance with this standard if its noise measured by method in Appendix A is not greater than value measured in type approval over 3 dB (A) or not greater than limited values stated in Table 1 over 1dB(A).

Appendix A (Regulated)

Method and equipment for noise measurement

Part I. Two-wheeled vehicle

A.1. Measurement of noise of moving vehicle

A.1.1. Measurement device

A.1.1.1. Sound level measurement

Sound level meter should have high accuracy as stated in IEC 651.

Measurement procedures should be implemented in “quick” time response and frequency property “A”. These requirements are also stated in above regulation.

When starting and finishing a sound level measurement series, measuring device should be calibrated under instruction of manufacturer by applying a suitable sound source (e.g. acoustic piston)

If deviation of sound level meter from this calibration is over 1dB in a measurement series, then the noise measurement procedure is considered to be inaccurate.

A.1.1.2. Measurement of vehicle velocity and engine speed

Rotating speed of engine and velocity of vehicle on testing road should be measured with deviation of $\pm 3\%$

A.1.2. Measurement condition

A.1.2.1. Vehicle condition

Vehicle should always be ready for moving (including cooling liquid, lubricating oil, fuel, tool set, spare wheel and driver).

Before measurement procedure, vehicle’s engine should be ignited and vehicle reaches normal working temperature. If vehicle is equipped with automated fan system, this system should not cause any influence during the measurement. For vehicle with two driving wheels or more, the driving wheel is only used in normal moving condition on the road. For vehicle with side tank, the tank should be removed from the vehicle.

A.1.2.2. Test area

Testing area should have a flat and smooth road length for accelerating speed at the middle of testing area. Road length for accelerating speed should be horizontal located with dry surface and be designed so that rolling movement of wheel causes low noise.

On testing area and in free acoustic field, change in sound source at the middle portion of road length and microphone should be remain within 1dB. This requirement can be met if there are not any sound reflection objects such as fence, bridge or building within area far from center line of testing road not over 50m. Microphone should not be barred at any directions which can affect the acoustic field and there should not be any people standing between microphone and sound source. Measurement controller should not stand at any place affecting readings on the meter. Road surface on testing area should meet requirement in Annex B.

A.1.2.3. Other requirements

It is not allowed to implement the measurement in bad weather condition. It is required to ensure that result of the measurement is not affected by gust wind. For measuring, noise (at frequency A) from sound source other than vehicle and wind should be less than vehicle's noise at least 10dB (A). It is able to install on wind-proof ball (one kind of windproof shield) under condition that its influence on sensitivity and direction characteristic of microphone is considered. For measuring noise, if difference between surrounding noise and measured noise is within 10dB(A) to 16dB(A), then measured noise should be excluded with a suitable adjusted value as in chart in Figure A.1.

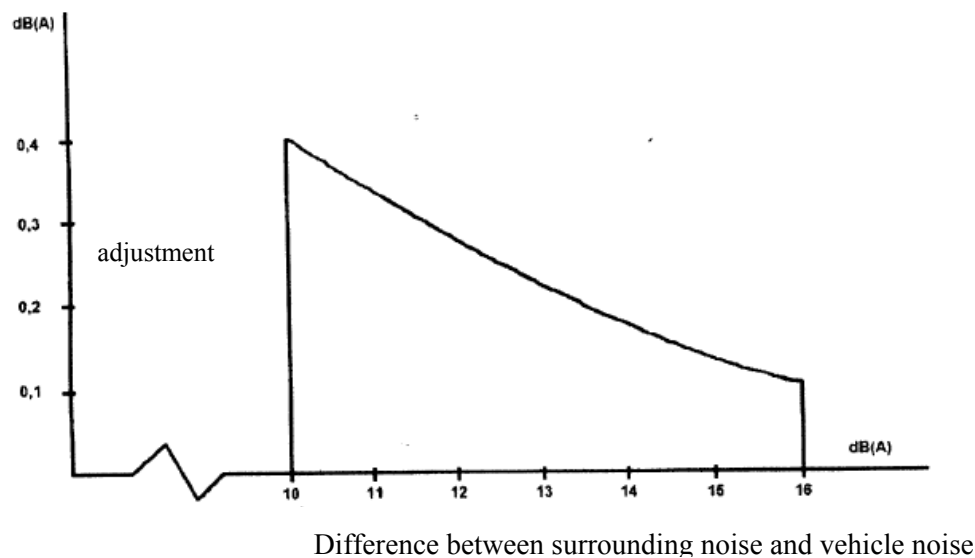


Figure A.1 - Adjustment of noise difference

A.1.2.4. Before measurement procedure, vehicle's engine should be in normal working condition in term of temperature, fuel, adjusted parameters, sparking plug, carburetor and other components.

A.1.3. Test method

A.1.3.1. Nature and number of measurements

Maximum noise (dB(A)) should be measured when vehicle runs between line AA' and BB' (Figure A.2). Measurement method will not be accurate if there is any unusual difference between top value and general noise.

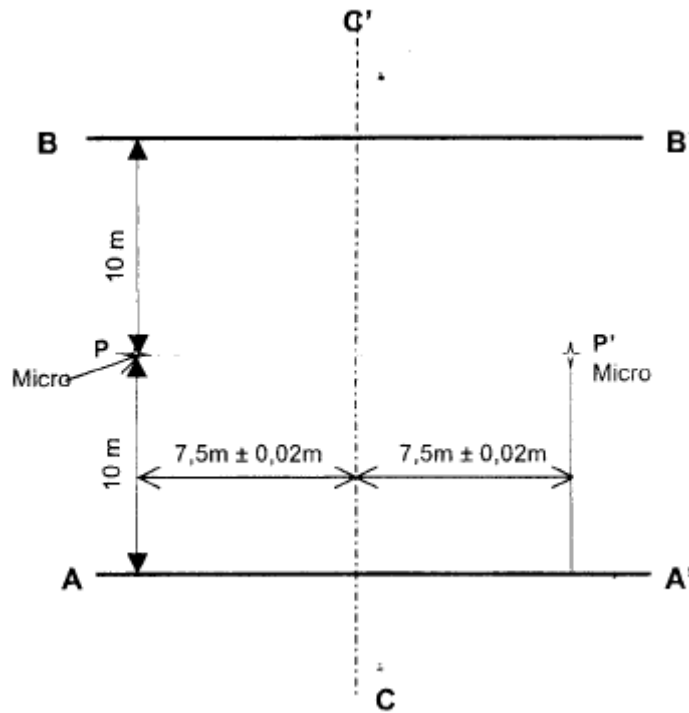
Noise measurement should be carried out at least two times for each side of vehicle.

A.1.3.2. Microphone position

Location of microphone should be from standard line CC' a distance of $7.5\text{m} \pm 0.2\text{m}$ (see Figure A.2) at a height of $1.2\text{m} \pm 0.1\text{m}$ compared with surface of testing area. Microphone should be pointed to line CC' and perpendicular to that line.

A.1.3.3. Vehicle operating condition

The vehicle should access to line AA' at a constant velocity which is initially stated in A.1.3.3.1 and A.1.3.3.2. When the vehicle reaches the line AA', throttle should be opened as quickly as possible and remained at that state until the vehicle's end touches line BB', then the throttle should be closed to the position corresponding with minimum unload speed of engine.



**Figure A.2 - Test for noise emitted from moving vehicle -
Measurement positions of microphone**

For all measurement methods, vehicle should run on a straight line on the whole accelerating road, at the mean time the median plane along vehicle as close to CC' line as possible.

A.1.3.3.1. Vehicle with non-automatic gearbox

A.1.3.3.1.1. Accessing velocity

Vehicle should access line AA' at a constant velocity equivalent to lower level among following values"

- a) 50km/h..
- b) Vehicle velocity when engine's speed equals to 75% of engine speed corresponding with maximum output of engine.

A.1.3.3.1.2. Selection of transmission ratio of gearbox

A.1.3.3.1.2.1. For all cylinder volume of engine, it is only allowed to test at second gear of gearbox if the gearbox has not over 4 gears.

A.1.3.3.1.2.2. Vehicle with cylinder volume of engine not greater than 175cm³ and gearbox with over and greater than 5 gears, it is only allowed to test at third gear.

A.1.3.3.1.2.3. Vehicles with cylinder volume of engine over 175cm³ and gearbox with over 5 levels should have test once at second gear and then one more time at third gear. Result obtained should be average value of the two tests.

A.1.3.3.1.2.4. During testing at the second gear (See A.1.3.3.1.2.1 and A.1.3.3.1.2.3), if speed of engine when vehicle accesses to the line marking final point of testing area exceeds 100% of speed corresponding with maximum output of engine, then testing procedure should be carried out at third gear and noise will only be recorded one time to be result of the test.

A.1.3.3.2. Vehicle with automatic gearbox

A.1.3.3.2.1. Vehicle without manual gearbox

A.1.3.3.2.1.1. Accessing velocity

Vehicle should access AA' line at a constant velocity of 30km/h, 40km/h and 50km/h or a velocity equal to 75% maximum speed if that value is lower. Selecting a condition generating the maximum noise.

A.1.3.3.2.2. Vehicle having manual gearbox with forward X seat at driving position**A.1.3.3.2.2.1. Accessing velocity**

Vehicle should access line AA' at constant velocity

- i) less than 50km/h, rotating speed of engine equal to 75% of speed corresponding with maximum output of engine; or
- ii) 50km/h, rotating speed of engine less than 75% of speed corresponding with maximum output of engine.

For constant velocity equal to 50km/h, gears reduce to the first gear then one accessing velocity can be increased to maximum velocity of 60km/h to avoid gear reserving.

A.1.3.3.2.2.2. Gearbox position

For vehicle having manual gearbox with forward X seat at driving position, testing procedure should be carried out for gearbox at the highest location. It is not allowed to use any devices for consciously changing to lower gear (e.g. kick-down²⁾). If there is any automatically lowering in gear behind line AA', it is required to retest at position of second gear or highest third gear, if necessary, to find the highest location of gearbox at which the test procedure can be implemented without any automatic gear reversing (not using kick-down).

A.1.4. Test result processing

A.1.4.1. Test report should present all environmental components which can affect result of the test.

A.1.4.2. Test result should be rounded to the most adjacent value in dB. If the first decimal number from 1 to 4, then test result will be rounded down, if this value is from 5 to 9, then test result will be rounded up.

Test results of two consecutive tests at the same side of vehicle which do not differ from each other over 2 dB(A) are considered accurate results and are informed in test report.

A.1.4.3. To estimate inaccuracy in testing procedures, result of each test procedure should equal to result obtained in A.1.4.2 subtracted to 1dB(A).

A.1.4.4. If average value of 4 results obtained in A.1.4.3 is not greater than noise limited value of vehicle corresponding with testing vehicle, then this value is considered to meet requirements of this standard stated in Table 1. This average value will be result of noise test procedure.

A.2. Noise measurement for parked vehicle**A.2.1. Noise in vehicle surrounding area**

To be convenient in testing noise for circulating vehicles, it is required to measure noise at area nearby exhaust pipe under following requirements. Result obtained will be presented in test report.

A.2.2. Measuring device

Sound level meter should be of the type stated in A.1.1.1.

A.2.3. Measuring condition

²⁾ "kick-down" is the gear lowering procedure of automatic gearbox by pushing accelerator to the floor.

During the measurement, gearbox should be at intermediate gear (gear 0).

A.2.3.1. Vehicle condition

Before measurement procedure, vehicle's engine should be ignited and vehicle reaches normal working temperature. If vehicle is equipped with automated fan system, this system should not cause any influence during the measurement.

If it is not able to stop force transmission, driving wheel of vehicle should freely rotate, i.e. by locating vehicle on middle support.

A.2.3.2. Test area (see Figure A.3)

Any area without considerable sound interfering object can be used as test area. Surface of test area should be flat, covered with concrete, asphalt concrete or other solid material with high sound reflection. It is not allowed to use compacted ground surface. Test area should be in rectangular shape of which each side will be far from external edge of vehicle (excluding steering wheel) at least 3m. There should be no considerable sound reflection object within this rectangular area, except driver and tester. Vehicle should locate inside this area so that microphone for noise measurement is far from edges of this area at least 1m.

A.2.3.3. Other requirements

Noise measured (at frequency A) from surrounding sound source and wind source should be less than vehicle's noise at least 10dB (A). It is able to install on wind-proof ball (one kind of windproof shield) under condition that its influence on sensitivity and direction characteristic of microphone is considered.

A. 2.4. Measurement method

A.2.4.1. Nature and number of test measurements

Maximum noise (dB(A)) should be measured during operation of vehicle stated in A.2.4.3.

It is required to implement at least three times for each measurement.

A.2.4.2. Microphone location (see Figure A.3)

The microphone should be placed at an equivalent position with the exhaust pipe or 0.5m from vehicle parking surface, whichever higher.

Microphone diagram should be faced and far from exhaust mouth 0.5m. Microphone axle with highest sensitivity should be placed in parallel with vehicle parking surface and form with vertical plane of direction of exhaust air an angle of $45^{\circ} \pm 10'$.

NOTE: ⁽¹⁾ This diagram vibrates when responding acoustic wave hitting it then other components change this vibration into electric signal to define sound level.

According to angle relationship with this vertical plane, microphone should be placed at the greatest distance from outer edge of vehicle (except for handle of steering wheel).

If exhaust system contains more than one exhaust pipe mouth of which center lines are far from each other under 0.3m, then microphone should be faced to the mouth nearest vehicle (except for handle of steering wheel) or toward the mouth at highest position from vehicle parking surface.

If center lines of exhaust mouth are far from each other over 0.3m, there should be independent measurement for each exhaust mouth, the highest value will be valid result.

A.2.4.3. Vehicle operation condition

Engine speed should be stable within one of two following values:

+ S/2, if S is greater than 5000 r/min.

+ 3S/4, if S is not greater than 5000 r/min.

Where S is engine speed corresponding with maximum output of engine.

When reaching constant engine speed, throttle should immediately be turned back to original position where engine operates at minimum unload rotating condition. Noise measurement should be implemented in both operation conditions including a short time when engine speed is constant and in above decelerating operation, the highest value will be the test result.

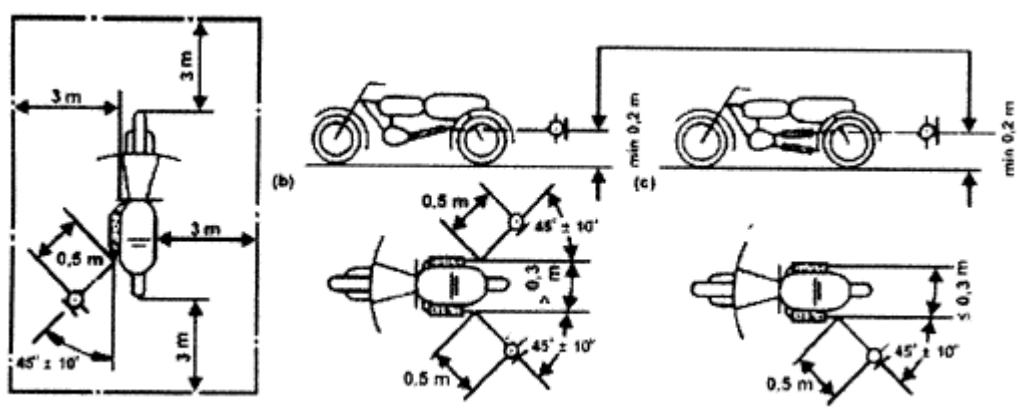
A.2.5. Test result

A.2.5.1 Test report should include all related data, especially data for measuring noise of parking vehicle.

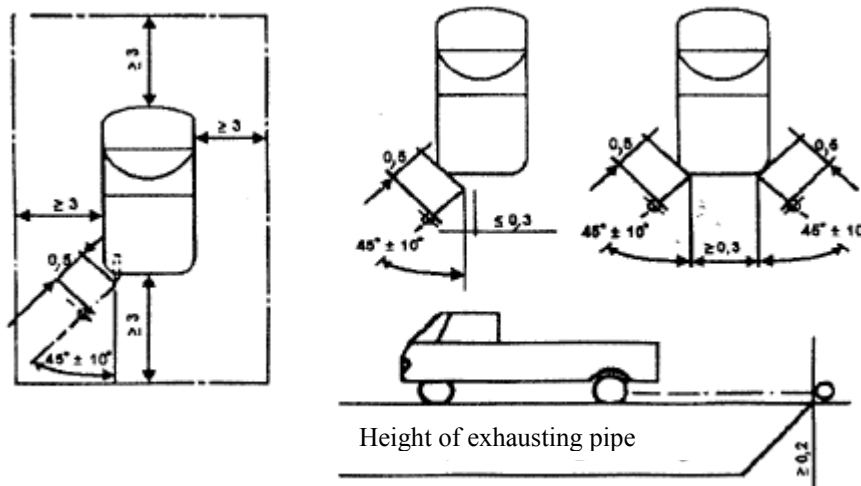
A.2.5.2. Test results should be rounded to nearest integral value dB and should be read out from measurement instrument.

If the first decimal number is from 1 to 4, reading value will be rounded down, if it is from 5 to 9, the reading value will be rounded up. Only results obtained from three consecutive measurements with difference not over 2dB are considered valid result.

A.2.5.3. Highest value in above measurement values is result of noise test



Dimensions in meter



**Figure A.3 - Position of microphone for measuring noise of static vehicles,
Height of exhausting pipe**

Part II. For three-wheeled vehicle

A.3. Instrument and condition for measurement

Instrument and condition for measurement are the same as in A.1.1 and A.1.2.

Besides, three –wheeled vehicle taking the noise measurement should be unloaded and have not trailer or semi-trailer.

A.4. Measurement method

A.4.1. Noise measurement for moving vehicle

A.4.1.1. Nature and number of measurements: as stated in A.1.3.1. Besides, it is able to use primary measurements before testing to adjust instrument but results obtained should not be used to estimate vehicle noise.

A.4.1.2. Microphone position: as in A.1.3.2, see Figure A.3.

A.4.1.3. Vehicle operation condition

Vehicle should access line AA' at originally constant velocity stated in following presentation. When the vehicle reaches the line AA', throttle should be opened as quickly as possible and remained at that state until the vehicle's end touches line BB', then the throttle should be closed to the position corresponding with minimum unload speed of engine.

For vehicle having semi-trailer permanently connected to form an integral group, vehicle's tail to reach BB' line should not be tail of semi-trailer, but real tail of the vehicle.

A.4.1.4. Test results should be rounded to nearest integral value dB and should be read out from measurement instrument. If the first decimal number is from 1 to 4, reading value will be rounded down, if it is from 5 to 9, the reading value will be rounded up. Only results obtained from three consecutive measurements with difference not over 2dB are considered valid result.

Measurement result should be determined as regulated in A.5.

A.4.1.5. Determination of constant velocity

A.4.1.5.1. For vehicle without gearbox

Vehicle should access line AA' at a constant velocity corresponding with minimum value among following velocity values:

- 1) Vehicle velocity when engine speed equal to 75% maximum engine output.
- 2) Vehicle velocity when engine speed equal to 75% maximum engine speed allowed by transmission governor.
- 3) Vehicle velocity equal to 50km/h.

A.4.1.5.2. Vehicle with manual gearbox

For vehicle having manual gearbox with 2 to 4 gears, it is required to use the second gear. For vehicle having gearbox with over 4 gears, it is required to use the third gear. If this application of gear lead to situation that engine speed exceeds maximum acceptable speed, then it is required to use the adjacent higher gear than the second or third gear, which should ensure to have this speed situation not longer

than the time the vehicle run through line BB' of test area. It is not able to use auxiliary gear with accelerating transmission ratio (accelerating gear). For vehicle having difference with two transmission ratios, then ratio selected should be the one allowing the vehicle to run at greatest velocity.

A.4.1.5.3. Vehicle with automatic gearbox

Vehicle should access line AA' at constant velocity equivalent to minimum value among following velocity values:

- 1) Vehicle velocity equal to 75% of maximum velocity
- 2) Vehicle velocity equal to 50km/h.

If there is any position of forward gear, that gear should be selected and lead to maximum average acceleration of vehicle between line AA' and line BB'. Location of gear at which it is only used to brake, to park or run slowly should not be used.

A.4.2. Noise measurement for parking vehicle

To be convenient for measuring noise of circulating vehicles, it is required to measure noise at surrounding area of exhaust pipe (silencing system) under following requirements. Result should be noted in test report.

A.4.2.2. Measurement condition

A.4.2.2.1. Vehicle condition

Before measurement procedure, vehicle's engine should be ignited and vehicle reaches normal working temperature. If vehicle is equipped with automated fan system, this system should not cause any influence during the measurement.

During the measurement, it is required to place gearbox at intermediate gear (gear 0).

If it is not able to stop force transmission, driving wheel of vehicle should freely rotate, i.e. by locating vehicle on middle support.

A.4.2.2.2. Test area

Any area without considerable sound interfering object can be used as test area. Surface of test area should be flat, covered with concrete, asphalt concrete or other solid material with high sound reflection. It is not allowed to use compacted ground surface. Test area should be in rectangular shape of which each side will be far from external edge of vehicle (excluding steering wheel) at least 3m. There should be no considerable sound reflection object within this rectangular area, except driver and tester. Vehicle should locate inside this area so that microphone for noise measurement is far from edges of this area at least 1m.

A.4.2.2.3. Other requirements

Noise measured (at frequency A) from surrounding sound source and wind source should be less than vehicle's noise at least 10dB (A). It is able to install on wind-proof ball (one kind of windproof shield) under condition that its influence on sensitivity and direction characteristic of microphone is considered.

A. 4.2.3. Measurement method

A.4.2.3.1. Number of test measurements

Measurement should be implemented at least three times at each position, maximum noise (dB(A)) should be measured during operation of vehicle stated in A.4.2.3.3.

Only result of three consecutive measurement at the same side of vehicle with difference not over 2dB(A) is considered to be valid. Maximum value in this measurement procedure will be accepted.

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A.4.2.3.2. Microphone position

As stated in A.2.4.2

A.4.2.3.3. Operation condition

As stated in A.2.4.3.

Measurement results should be rounded to the nearest dB value and should be read out from the measurement instrument. If the first decimal number is from 1 to 4, then result will be rounded down, if this number is from 5 to 9, the result will be rounded up.

Only result of three consecutive measurement at the same side of vehicle with difference not over 2dB(A) is considered to be valid. Highest value in this measurement procedure will be accepted.

A.5. Processing measurement results for moving vehicle

A.5.1. Test report should present all environmental factors which can affect the result.

A.5.2. Measurement results should be rounded to the nearest dB value. If the first decimal number is from 1 to 4, then result will be rounded down, if this number is from 5 to 9, the result will be rounded up.

Result of two consecutive measurements at the same side of vehicle with difference not over 2dB(A) is considered to be valid and should be presented in test report.

A.5.3. To estimate inaccuracy in measurement, result of each measurement should be equal to result obtained in A.5.2 subtracted to 1dB (A).

A.5.4. If average value of four measurements (each vehicle side providing two results) which are obtained in A.5.3 does not exceed noise limitation value for vehicle type corresponding with tested vehicle, then this value is considered to meet requirement of this standard stated in Table 1. This average value will be result of noise test measurement.

ANNEX B (Regulated)

Requirements for test area

B.1. Introduction

This Annex presents requirements related to physical characteristics and arrangement of test lines. These requirements base on special standard ³⁾ which describes essentially physical characteristic as well as test methods for these characteristics.

B.2. Surface characteristics

Surface is considered to be in compliance with this standard if its structure and void or sound absorption coefficient are proved to meet all requirements from B.2.1 to B.2.4 and meet designing requirements (B.3.2).

B.2.1. Residual void ratio

Residual void ratio, V_c , of material compound for paving test line should not be greater than 8%. For measurement procedure, see B.4.1.

B.2.2. Sound absorption coefficient

If surface does not meet requirement for residual void ratio, that surface will only be accepted when sound absorption coefficient $\alpha \leq 0.10$.

NOTE: The most related characteristic is sound absorption coefficient despite that residual void ratio is more popular for road builder. However, it is required to measure sound absorption coefficient only when the surface is not compliant with requirement for residual void ratio. That is because void ratio relates to many uncertainties in time manner of the two measurements, then some surfaces can be wrongly dismissed when basing only on void measurement.

B.2.3. Structure depth

Structure depth (TD) measured uniformity

Practically, it is required to ensure test surface in test area as uniform as possible. This includes uniformity in structure and void ratio, but it is also required to check out the surface to find whether the rolling compaction gives different impact at different positions then the structure can be different and unevenness causing hard shock for vehicle can also happen.

B.2.5. Periodical examination

To check whether the surface still meet requirement for structure and residual void ratio or sound absorption coefficient stated in this standard or not, it is required to implement periodical examinations at following periods:

a) For residual void ratio or sound absorption coefficient:

+ When the surface is newly formed

+ If the surface does meet requirements when it is new, it is not required to have periodical examination. Otherwise, it is able to check later because surface tends to be close and compacted over time.

b) For structure depth (TD)

+ When the surface is new.

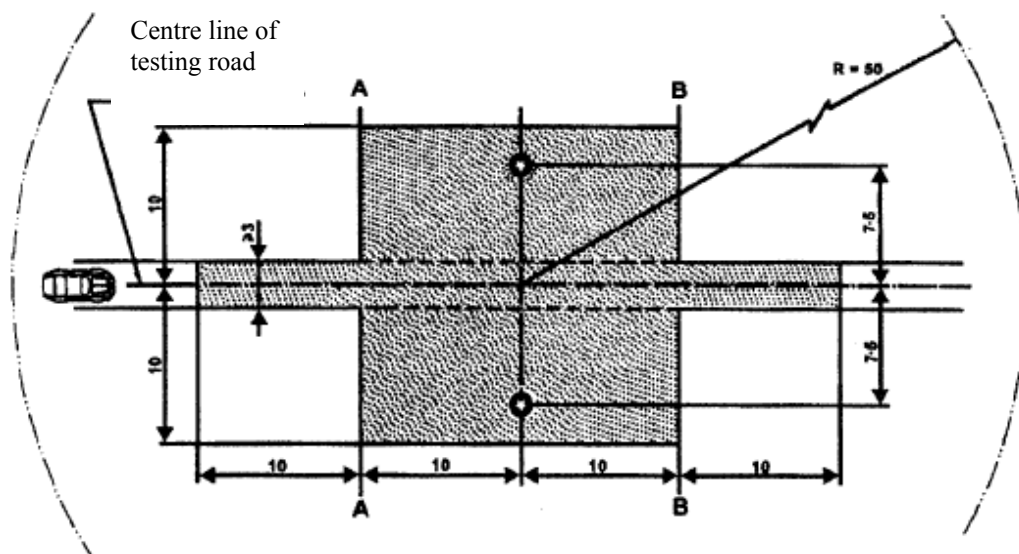
+ When starting noise test (not less than four weeks after covering the surface)


+ The next period for examination is 12 months.

B.3. Test surface design

B.3.1. Area

For generally designing test lines, the important point is to ensure that area passed by vehicle on test line is covered by test material regulated for road for safe driving and practically. This requires a width of test line of at least 3m and a length exceeding line AA' and BB' at least 10m at each end. Figure B.1 presents a chart of a suitable test side and indicates the minimum area for being built by road paving machine and compacting machine with regulated test material. According to A.1.3.1, measurements should be carried out at each side of vehicle. This can be implemented by measuring with two microphones (each one at a side of test line) and driving the vehicle in one direction or by measuring with a microphone but driving vehicle in both directions. For later situation, it is not required to apply surface requirement for the test line without microphone.



Note:  Minimum area with testing line (testing area)

 Positions of microphone (height of 1.2m)

NOTE: It is not allowed to have big-size noise reacting objects within radius of this area

Figure B.1 - Minimum requirements for area of testing surface

Dark part is called “testing area”

B.3.2. Surface design and preparation

B.3.2.1. Basic design requirements

Test surface should meet four design requirements:

B.3.2.1.1. Solid asphalt concrete

B.3.2.1.2. Maximum dimension of stone covering surface should be 8mm (allowable deviation from 6.3mm to 10mm).

B.3.2.1.3. Thickness of road cover should not be less than 30mm.

B.3.2.1.4. Binding material should be directly penetrated asphalt without property changeability.

B.3.2.2. Design instruction

For instructing builder of test surface, aggregate characteristic line in Figure B.2 will provide desired characteristics. Besides, Table B.1 will provide some instructions to obtain required structure and strength. Aggregate characteristic line is compliant with following formula:

$$P(\% \text{ sieving}) = 100 \times (d/d_{\max})^{1/2}$$

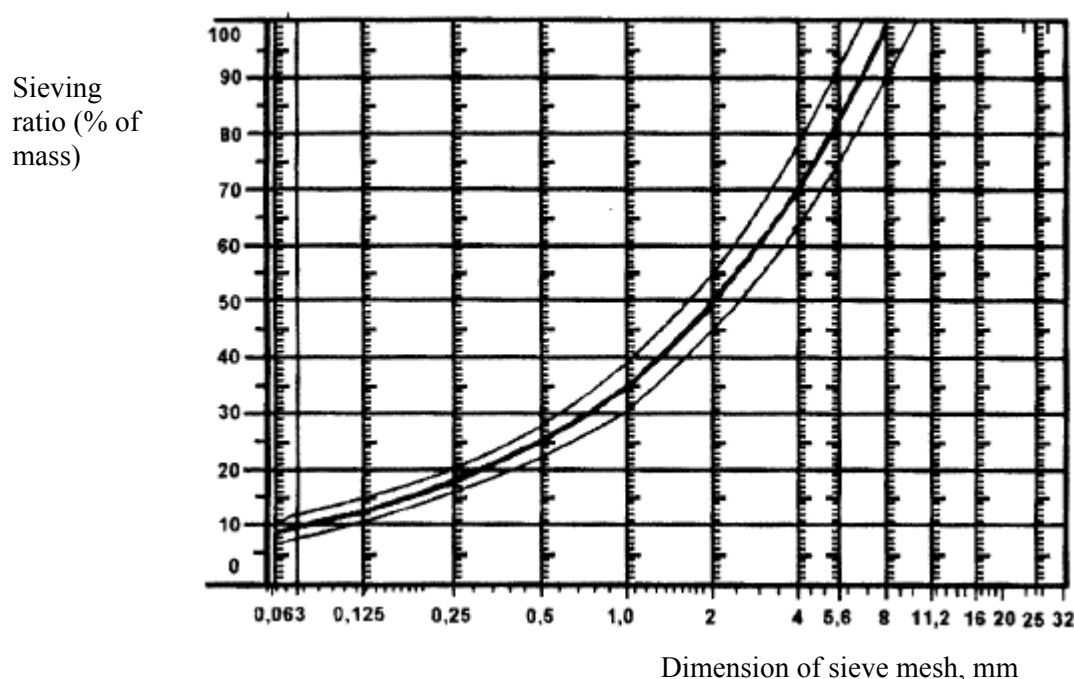
Where:

d: dimension of side of square sieve mesh, in millimeter.

d_{\max} : 8mm for middle curve

d_{\max} : 10mm for lower deviation curve

d_{\max} : 6.3mm for upper deviation curve.



**Figure B.2 – Aggregate characteristic line (with deviation)
in asphalt concrete compound**

In addition to above requirements, it is recommended that:

- Sand fragmentation ($0.063\text{mm} < (\text{dimension of side of square sieve mesh, SM}) < 2\text{mm}$) should include at least 45% fined sand and not greater than 55% of natural sand.
- Ground and bedding should be ensured to have stability and good evenness, meeting requirement for the best road structure.
- Road metal should be crushed (100% crushed for surface) and be made of material with high crushability;
- Road metal using in compound should be cleaned.
- It is not allowed to add road metal on surface;
- Solidness of binding material (unit of PEN) should be equal to 40-60, 60-80 or even 80-100, depending on climate condition. Binding material is more solid is better but still in compliance with general regulation;

g) Compound temperature before rolling should be selected to obtain residual void ratio at the next rolling. To increase ability to meet requirement in B.2.1 to B.2.4, compactness should be examined not only by selection of proper compound temperature but also by suitable number of sieving granular and selection of rolling machine.

Table B.1 – Instruction for designing

	Target values		Tolerance
	According to total mass of compound	According to aggregate mass	
Mass of stone going through square sieve mesh (SM)>2mm	47.6%	50.5%	±5
Sand mass, 0.063<SM<2mm	38.0%	40.3%	±5
Filer mass, SM >0.063mm	8.8%	9.3%	±5
Binding material mass (asphalt)	5.8%	-	±5
Maximum dimension of road metal	8mm		6.3 – 10
Solidness of binding material	(See B.3.2.2(f))		-
Polished stone value (PSV)	> 50		-
Compactness, compared with Marshall compactness	98%		-

B.4. Test method

B.4.1. Residual void ratio measurement

According to this measurement aim, samples (cylindrical shaped, pear-shaped...) should be taken from test line at minimum four positions of even distance among test area between AA’ and BB’ (see Figure B.1). To avoid non-uniformity and unevenness of vehicle wheel treads, samples should not be taken directly from wheel treads but adjacent to them. At least two samples will be taken adjacently to wheel treads and at least one sample should be taken near the middle line of wheel tread and microphone positions.

If arising any doubt that uniformity requirement is not satisfied (see B.2.4), it is required to take samples at more positions in test area.

Residual void ratio should be determined for each sample then an average value will be determined and compared with requirements in B.2.1. Besides, there should be no sample having void ratio over 10%. Builder of test surface should take into account possible problems when test area has heat application from pipes and electrical wires and samples should be taken from this area. For such arrangement, it is required to have careful planning relating to future sampling positions. It is suggested to leave some

positions with dimension equivalent to 200mm x 300mm of which there should not be any wire/pipe or pipes should be installed deeply enough to prevent any damage caused by surface sampling.

B.4.2. Sound absorption coefficient

Sound absorption coefficient (perpendicular incidence) should be measured by impedance tube as regulated in ISO 10534.

It is required to follow all regulations related to samples the same as to satisfy all requirements related to residual void ratio (see B.4.1). Sound absorption coefficient should be measured in frequency band of 400Hz to 800Hz and frequency band from 800 Hz to 1600Hz (at least at frequency values among eighth frequency domain) and maximum value should be determined for both these frequency bands. Then these values for all samples should be averaged to have final result.

B.4.3. Measurement for great structure by volume

According to this standard's aim, measurement for surface structure depth should be implemented at minimum ten positions of even distance along wheel tread of test line. Values of these measurements then should be averaged to compare with regulated minimum surface structure depth. See ISO 10844 for detail of measurement procedure.

B.5. Chronological stability and maintenance

B.5.1. Life influence

Similar to other surfaces, tyre /road noise can be increased a little after construction in a time period of the first 6 to 12 months. At least in four weeks, surface will satisfy all requirements after construction.

Chronological stability is mainly determined by smoothness and compactness when vehicle running on surface. It should be periodically examined as in B.2.5.

B.5.2. Surface maintenance

Fragments or dust which can reduce considerably structure depth should be removed from surface. In areas with cold climate, sometimes people use salt to defrost but this should be restricted because salt can temporarily or permanently change surface structure causing noise increase.

B.5.3. Repaving surface of test area

For requirement of repaving surface of test area, generally it is not required to repave a surface greater than test track (about 3m in width in Figure B.1) if test area outside that track still meet requirements for residual void ratio or sound absorption coefficient when measurement.

B.6. Documents for test surface and test methods on this surface

B.6.1. Documents for test surface

Following data should be presented in document describing test surface:

B.6.1.1. Position of test road

B.6.1.2. Type of binding material, solidness of binding material, type of aggregate, maximum theoretical density of concrete (DR), thickness of hardwearing layer and aggregate supply curve determined from samples taken from test road.

B.6.1.3. Compaction method (type of roller wheel, weight of roller wheel, time of rolling)

B.6.1.4. Mixture temperature, surrounding climate and wind velocity during surface pavement.

B.6.1.5. Date of surface pavement and bidder.

B.6.1.5.1. Residual void ratio of each sample.

B.6.1.6.2. Positions of test area where samples are taken for residual void ratio measurement.

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B.6.1.6.3. Sound absorption coefficient of each sample (if measurement). Result determination for each sample, each frequency band as well as average value.

B.6.1.6.5. Structure depth, including number of tests and standard error.

B.6.1.6.6. Authority for testing in B.6.1.6.1 and B.6.1.6.2 and type of applied instrument.

B.6.1.6.7. Date of test and date of sampling for test track.

B.6.2. Document of noise test implementation on surface

It is required to present whether all requirements of this standard are met or not. Refer document to C.6.1 to describe all result confirming this information.

ANNEX C

(Regulated)

Exhaust system (silencing system) containing fiber material

C.1. Fiber absorption material should not be asbestine and should be used to manufacture silencing system only when there is suitable component ensuring that fiber material is remained in its position during the whole time using silencing system. This type of material should also meet requirements in C.1.1, C.1.2 and C.1.3.

C.1.1. After removing fiber material out of silencing system, noise should meet requirements in Annex A and noise limitation stated in Table 1.

C.1.2. Fiber absorption material can be excluded in components of silencing system which has exhaust pipe running through and should be in compliance with following requirements:

C.1.2.1. Material should be heated to a temperature of $650^{\circ}\text{C}\pm 5^{\circ}\text{C}$ in four hours in oven without being reduced in length, diameter and fiber bulk density.

C.1.2.2. After heating at temperature of $650^{\circ}\text{C}\pm 5^{\circ}\text{C}$ in one hour in oven, at least 98% of material still remaining in the sieve with nominal mesh dimension of $250\mu\text{m}$ in compliance with TCVN ISO 3310/1: 1990 when testing in accordance with ISO 2599.

C.1.2.3. Loss in material mass should not exceed 10.5% after soaking this material in a temperature of $90^{\circ}\text{C}\pm 5^{\circ}\text{C}$ in about 24 hours in a condensation mixture of following components:

1N hydrobromic acid (HBr): 10ml

1N sulphuric acid (H_2SO_4): 10ml

Distilled water for mixing: up to 1000ml.

NOTE: Material should be washed in distilled water and dried at a temperature of 105°C in one hour before weighting.

C.1.3. Before system is tested in accordance with Annex A, it should be brought into normal working condition on road by one of following normalization methods:

C.1.3.1. Normalization by continuous running on road

C.1.3.1.1. For types of vehicle, minimum road length for a vehicle to run in normalization is:

Table C.1 – Running road of vehicle according to cylinder capacity

Type of vehicle	Cylinder capacity, C (cm^3)		Running road length (km)
	Two-wheeled vehicle	Three-wheeled vehicle	
Type I	$C \leq 80$	$C \leq 250$	4000
Type II	$80 < C \leq 175$	$250 < C \leq 500$	6000
Type III	$C > 175$	$C > 500$	8000

7. Quick-action valve, such as exhaust break valve with diameter of 60mm, activated by a compressed air container with active force of 120N at a pressure of 4 bar. Responding time including in opening and closing should not be greater than 0.5s.
8. Bringing exhaust air out.
9. Flexible pipe.
10. Pressure gauge.

Figure C.1 – Test instrument for normalization by vibration

C.1.3.2.4. Time delay switch should be set for time existing of exhaust air calculated basing on requirements in C.1.3.2.3.

C.1.3.2.5. Engine speed should equal to 75% of S speed corresponding with maximum engine output.

C.1.3.2.6. Indicated power on test panel should equal to 50% of throttle full open power measured at a speed of 75% of S speed.

C.1.3.2.7. All drain opening should be closed during the test.

C.1.3.2.8. All tests should be finished within 48 hours. If necessary, there should be one cooling state after each hour.

C.1.3.3. Normalization by running on test panel

C.1.3.3.1. Exhaust system should be installed on engine represented for engine type used for vehicle having designed exhaust system, then engine/vehicle will be placed on test panel.

C.1.3.3.2. Normalization process includes a running on test panel stated in C.1.3.3.4 for each vehicle type having designed exhaust system. Number of running cycles on test panel for each vehicle type is presented in Table C.2.

**Table C.2 – Number of running cycles for each vehicle type
according to cylinder capacity**

Type of vehicle	Cylinder capacity, C (cm ³)		Number of running cycles
	Two-wheeled vehicle	Three-wheeled vehicle	
Type I	$C \leq 80$	$C \leq 250$	6
Type II	$80 < C \leq 175$	$250 < C \leq 500$	9
Type III	> 175	$C > 500$	12

C.1.3.3.3. After each running cycle, there should be a resting stage in at least six hours to reproduce influence of cooling and condensation.

C.1.3.3.4. Each running cycle on test panel has six phases. Conditions for engine and time of each phase are presented in Table C.3.

Table C.3 – Conditions for engines and time of each phase

Phase	Condition for engine	Time of each phase (minute)			
		Two-wheeled vehicle		Three-wheeled vehicle	
		Engine \leq 175cm ³	Engine $>$ 175cm ³	Engine <250cm ³	Engine \geq 250cm ³
1	Minimum unload	6	6	6	6
2	25% load at 75% S	40	50	40	50
3	50% load at 75%S	40	50	40	50
4	100% load at 75%S	30	10	30	10
5	50% load at 100%S	12	12	12	12
6	25% load at 100% S	22	22	22	22
Total time		150	150	150	150

C.1.3.3.5. During this normalization, under requirements of manufacturer, engine and silencing system can be cooled so that temperature at position from exhaust mouth not over 100mm does not exceed measured value when vehicle operates at highest gear with velocity of 110km/h or engine speed of 75% S. Engine speed and/or vehicle is determined with error of $\pm 3\%$.

C.2. Silencing system in input

If it is required to install an air filter and/or silencing system in engine input to be in compliance with noise limitation, that air filter and/or silencing system should be considered to be one component of vehicle silencing and therefore should meet requirements in C.1.