Measurement of exhaust pipe sound pressure levels of stationary scooters, mopeds or motorcycles with automatic transmissions with no neutral

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Introduction

This method of measuring sound pressure level was developed for evaluation of sound pressure levels (dB_A) emitted by scooter, moped or motorcycle exhaust pipes with automatic transmissions when the vehicles are in a stationary position. The method can be used for road checks on vehicles[1] to enforce laws limiting the noise level of vehicles (more specifically, mopeds, scooters and motorcycles with automatic transmission). It can also be used to evaluate the extent to which these vehicles meet the requirements of a regulation on the total level of noise permitted (Schedule V.1 - Noise Emissions (Standard 1106) - *Motor Vehicle Safety Regulations* (C.R.C. c. 1038), EPA); however, this method does not measure the maximum total sound level pressure (total noise) of the accelerating vehicle, but only the sound pressure level emitted by the exhaust pipes when the vehicle is stationary. This standard does not replace Canadian regulations for the approval of mopeds, scooters or motorcycles for the Canadian market. In all cases, the method measures the sound pressure level emitted by the exhaust pipes for a vehicle during a test and at a given engine rpm. No extrapolation from this measurement can be made.

The purpose of this standard is to monitor the level of sound emissions from vehicles once they are on the market. The standard can also be used as a tool for users and automotive dealers to ensure compliant vehicle maintenance once vehicles are in use.

A limit for sound pressure level is proposed in Section 8.1. This limit was determined so that a vehicle complies with approved limits set out in Standard 1106, is below the proposed limit. A margin is included to take into account normal wear on the vehicle.

The purposes of this standard are:

- road check of vehicles by the proper authorities;
- verification of the sound pressure level for a given set of parameters by automotive dealers and users following maintenance or replacement of a part of the exhaust system.

This method differs on certain points from the American standard SAE J2825.

[1] The term "vehicle" in this document covers mopeds, scooters and motorcycles with automatic transmissions. Other types of vehicles (motorcycles, automobiles, etc.) are not covered by this term.

1 Field of application

This standard details a test procedure, an environment and the instrumentation to be used to measure sound pressure levels emitted by exhaust systems of vehicles while stopped (stationary vehicles). This measurement differs from the measurement of total sound pressure levels for a moving vehicle (ISO 362-2, SAE J47, Standard 1106, EPA Part 205, CEE 41) and other methods of measuring sound pressure level for stationary vehicles (ISO 5130, SAE 1287, SAE J2825, CEE 41).

The main purpose for this standard is vehicle road checks. The procedures were written to facilitate road checks and avoid the risk of error.

This standard is applicable to mopeds, scooters and motorcycles with automatic transmissions that do not have a neutral position (scooter type) and excludes motorcycles with a transmission with a neutral position.

2 References

2.1 Standards referenced

The following references are part of this standard. If more recent versions exist, they are the ones that apply.

ANSI S1.4-1983 (R 2006) (including Amendment S1.4a-1985) *Specification for Sound Level Meters*

ANSI S1.40-2006 *Specifications and Verification Procedures for Sound Calibrators*

CEI/IEC 61672-1: 2002 *Electroacoustics – Sound level meters – Part 1: Specifications*

CEI/IEC 60942: 2003 *Electroacoustics – Sound calibrators*

2.2 Other references

ISO 362-2: 2007 *Measurement of noise emitted by accelerating road vehicles -- Engineering method -- Part 2: L category*.

ISO 5130: 2007 Acoustics – *Measurement of sound pressure level emitted by stationary road vehicles*

SAE J47 *Maximum Sound Level Potential for Motorcycles*

SAE J331 *Sound Levels for Motorcycles*

SAE J1287 *Measurement of Exhaust Sound Pressure Levels of Stationary Motorcycles*

SAE J2825 *Measurement of Exhaust Sound Pressure Levels of Stationary On-Highway Motorcycles*

Environmental Protection Agency (EPA), US Government – *Title 40, Part 205 Transportation Equipment Noise Emission Controls*

Transport Canada, *Motor Vehicle Safety Regulations* (C.R.C., c. 1038) Schedule V.1 – Noise Emissions (Standard 1106)

ECE, Regulation No. 41 - Appendix 3: *Methods and instruments for measuring noise made by motor cycles*

3 Definitions

3.1 Sound pressure level

Sound pressure level is the measurement of the variation in air pressure that sounds produce. In everyday language, we often use the expressions *noise level* or *sound level*. The unit of measurement for sound pressure level is the decibel (dB). In practice, measurements take into account the way the human ear reacts to the sound frequency, and the measurements taken are weighted to take this fact into consideration. The weighting that corresponds to human hearing is called A-frequency-weighting. When noting sound pressure levels, this measurement scale appears in the units, that is, dB_A or dBA for decibels with an A-weighting.

3.2 LAF_{MAX}

Sound pressure level ("Level") with A frequency-weighting and fast time-weighting ("Fast"). The "MAX" subscript indicates the maximum value produced during a measurement interval.

3.3 Measurement series

All measurements made consecutively on the same site, the same day, by the s ame operators and under similar conditions.

3.4 Engine rpm, engine speed

Speed of engine rotations expressed in revolutions per minute (rpm). Constant engine rpm is when the engine speed is maintained at a fixed value during measurement. Variable engine rpm is when the speed is progressively increased until a pre-determined final value is reached during measurement. Idling rpm is the speed when the engine is running and the throttle is not used.

3.5 Sound meter calibration

Sound meter calibration is an operation in which a device called a calibrator is applied to the sound meter microphone to verify (calibration verification) or calibrate the accuracy of the sound meter (calibration). A typical calibrator installed on a microphone produces a sound at a frequency of 1000 hertz at 94 dB_A level. The sound meter will indicate the value if it is equipped with a *random incidence* microphone. If the sound meter is equipped with a *free field* microphone, it will indicate 93.85 dB_A.

4 Instrumentation

The following instrumentation shall be used:

4.1 A sound meter that complies with IEC 61672-1: 2002 standard or the ANSI S1.4-1983 (R2006) standard. Sound meters must be class 1 (as per IEC 61672-1) or type 1 or type 2 (as per ANSI S1.4). Class 2 sound meters (as per IEC 61672-1) must not be used for road checks whose purpose is to enforce laws or regulations. Class 1 and type 1 sound level meters are preferable.

The sound level meter must have the A frequency-weighting and F time-weighting (Fast).

The sound level meter must be able to memorize the maximum value produced during a measurement interval.

4.2 An extension cable recommended by the sound meter manufacturer to connect the microphone to the sound level meter.

4.3 A tripod to hold the microphone during measurement.

4.4 A windscreen recommended by the manufacturer that does not affect the microphone's response by more than ±1 dB for frequencies between 63 and 4000 Hz and not more than ±1.5 dB for frequencies between 4000 and 10000 Hz.

4.5 A class 1 acoustic calibrator to calibrate the sound level meter that meets the criteria of the IEC 60942: 2003 standard or the ANSI S1.40-2006 standard. Pistonphones shall not be used for calibration for this standard. The internal calibration of the devices must not be used as a means of calibrating for this standard.

4.6 A tachometer for external measurement of the engine rotation speed with an accuracy of within ±3% of the test speed. The tachometer can use mechanical, electromagnetic or acoustic means for measurement. The motorcycle's tachometer can be used (see section 6.1.8).

4.7 An anemometer (wind gauge) to measure wind speed with an accuracy of at least ±10%.

4.8 Two rectangular pieces of stiff rubber (for example, made from recycled tires). Suggested minimum size: 250 mm X 600 mm and 16 mm thick. One of the surfaces must be smooth (no grooves). A piece of rubber must be placed under the vehicle's center stand during the tests to stabilize it and lift the back wheel so that it does not touch the ground during rotation. In certain cases, two pieces must be laid one on top of the other in order to keep the wheel clear of the ground.

5 Test site and environment

The test site and environmental conditions during the test must meet the following requirements:

5.1 The site must be flat and free of anything that will reflect sound back (ex.: vehicles, curbs, road signs, buildings, slopes, trees, people, animals) for a distance of at least 2.5 m from the motorcycle and microphone (see Appendix A, Figure A.1). The sound level meter operator and an assistant can be within this zone if necessary. The tests must not be conducted indoors.

5.2 The ground in the test zone must be paved (asphalt or concrete) or else dirt. It must be free of loose matter (loose or sandy soil), grass or other matter.

5.3 The ground must be level. The average slope cannot be more than 40 mm/m (4% or 2.3 degrees).

5.4 The space above the test site must be clear (no branches or structures). The tests must not be conducted indoors.

5.5 Wind speed, including gusts, measured at a height of between 1.5 m and 2 m from the ground, must not be more than 10 m/s (36 km/h) during the test.

5.6 Air temperature must be between 5°C and 35°C[2].

5.7 Relative humidity must be between 25% and 90%[2].

5.8 The A-weighted sound pressure level for background noise, including wind, must be at least 10 dBA below the level of sound to be measured.

5.9 If the operator or assistant must be close to the vehicle during the measurement, they should stand as far away from the microphone as possible, and preferably, on the opposite side of the vehicle from the microphone.

[2] Weather forecasts can be used to evaluate whether the temperature and relative humidity are adequate for the tests. If necessary, measurements can be taken to ensure that these limits are not exceeded.

6 Procedures and measurement

6.1 General test conditions

6.1.1 The vehicle engine must be at normal running temperature during the test (warm engine).

6.1.2 The vehicle must rest on its center stand. A piece of rubber must be placed between the center stand and the ground to ensure vehicle stability and raise the rear wheel clear of the ground (if necessary, use two pieces of rubber one on top of the other). If the rubber has groovesz on one side, put that side face down on the ground, with center stand resting on the smooth side. The motorcycle rider should straddle the vehicle (without sitting on the seat, if possible) or stand beside the vehicle opposite to the side where the measurement is being made so that the rider can control the vehicle's engine speed. The rider must make any necessary manoeuvres to ensure vehicle stability, for example, pressing on the handlebars so that the wheel stays in contact with the ground. The sound level meter operator, placed as outlined in section 5.9, can help hold the vehicle so that it remains stable.

6.1.3 The rear wheel of the vehicle must turn freely during the test. Make sure no one stands behind the vehicle (debris could fly backwards when the wheel rotates or touches the ground if there is a wrong move) or in front (the vehicle could move forward if the rear wheel comes in contact with the ground).

6.1.4 If the vehicle is equipped with a noise control system, the system must be set to the maximum noise position.

6.1.5 The accuracy of the sound level meter must be checked with the acoustic calibrator immediately before the measurement series is conducted.[3] If the value displayed on the sound meter is more than 0.2 dB_A of the calibrator value, calibrate or adjust the sound meter. The meter's calibration should be checked at least once per hour. The calibration of the meter should also be checked immediately after a measurement series. The measurements between two verifications are valid if an adjustment of less than 0.5 dB_A is required.

6.1.6 The microphone must be placed behind the exhaust pipe at a distance of 50 cm ±2 cm from the reference point of the exhaust pipes (see Appendix A, Figure A.2), at the same height as the reference point ±2 cm if this point is more than 20 cm from the ground, or else 20 cm from the ground, on an imaginary line at a 45° angle ±10° with respect to the longitudinal axis of the vehicle. The microphone must be pointed at the reference point (regardless of the type of microphone). The microphone must be supported by a tripod, and no accessory used to position the microphone in relation to the exhaust pipe should

[3] A measurement series is a set of measurements taken by the same operators on the same site, on the same day, under the same genereal conditions and using the same device. A set of measurements can include measurements taken from different motorcycles (different vehicles).

be left in place (rope, ruler, square, etc.). The windscreen should be put on the microphone to take the measurement.

If there is more than one exhaust pipe on the same side of the vehicle, see Appendix A, Figure A.3 to determine which exhaust pipe to use for the measurement.

Figure A.4 of Appendix A gives indications about the choice of reference point to use on the exhaust pipes based on its geometry.

6.1.7 The sound meter must be set on the scale for A frequency-weighting and on the F time-weighting. It must be used in a measurement mode that memorizes the maximum sound pressure level (LAF_{MAX}) during the measurement period planned.

6.1.8 If the vehicle tachometer is used, the operator or an assistant must take the readings during the test. This person must stand on the side opposite the microphone, as described in section 5.9.

6.1.9 If the vehicle is equipped with an exhaust pipe on both sides, a measurement must be taken on both sides. The highest sound pressure level measured is the one to record. If the level measured on the first side exceeds the allowed limit, it is not necessary to test the other side.

6.1.10 Perform the test with constant engine rpm, as described in section 6.2.

6.2 Tests with constant engine rpm

6.2.1 Bring the engine up to the rotation speed prescribed for the test (see Table 1) and keep it at that rpm during measurement. A minimum of 2 seconds is required.

Table 1 Engine rpm prescribed for the road check of mopeds, scooters and motorcycles with an automatic transmission and no neutral position

Description of the vehicle	Engine rpm
Moped or scooter (cylinder capacity of 50 cc or less)	5000 rpm (±250 rpm)
Motorcycles with automatic transmission with no neutral position (cylinder capacity greater than 50 cc)	4000 rpm (±250 rpm)

If it is not possible to keep a stable constant engine rpm, use the test for variable engine rpm (Appendix B.1).

6.2.2 Measure sound pressure level. The measurement must be made for a minimum of 1 second during stable running of the engine. The LAF_{MAX} value during this 1-second period is the value of the sound pressure level issued by the exhaust pipe.

6.2.3 If the measurement obtained is 2 dB_A or less than the allowed limit, or greater than this limit, take a second measurement[4]. The maximum difference between both measurements cannot be more than 1.0 dB_A for the test to be considered valid. Both measurements must be taken while maintaining the engine rpm over a long enough period or by redoing the procedure after slowing the motor to idle.

If it is impossible to obtain this accuracy after several measurements, use the test at variable engine rpm (Appendix B.1).

[4] It is recommended, but not required, that the calibration be checked between the two measurements, or immediately after the two measurements if they have been performed without interrupting the vehicle's engine speed, in order to ensure that the measurements are valid. If the verification of the sound level meter shows a difference of more than 0.5 dB in relation to the last verification, calibrate or adjust the meter and carry out the two measurements again.

7 Measurement results

7.1 The result of the measurements is the maximum sound pressure level LAF_{MAX} if only one measurement is taken (section 6.2.2), or the maximum value of the two measurements if two measurements are made (section 6.2.3). The result is rounded off to the nearest 0.1 dB_A.

If the test at variable engine rpm (Appendix B.1) or the test at idle engine rpm (Appendix B.2) has to be used, refer to the corresponding Appendix for the results of the measurement and its interpretation.

8 Interpretation of the results

8.1 The limits for a road check and the enforcement of laws and regulations on noise levels are:

Prescribed limit for mopeds and scooters	**90 dB_A**
Prescribed limit for all motorcycles covered by this standard and tested at constant or variable engine rpm	**100 dB_A**

8.2 Other applications

The result of the measurements determined by Section 7.1 must be used as is for any other application.

9 Report

The following data must be noted in the measurement report.

9.1 Vehicle identification (serial number or vehicle registration number), the make, model and year, number of cylinders and engine capacity.

9.2 The maximum sound level pressure obtained in section 7.1.

9.3 The procedure used: constant engine rpm (section 6.2), variable engine rpm (Appendix B.1) or idle engine rpm (Appendix B.2).

9.4 The engine rotation speed during the measurements (except for idling) and the measurement method used.

9.5 The indication whether the sound pressure level has exceeded the prescribed limit, as outlined in Section 8.1 or in Section B.2.5.

9.6 Maximum wind speed

9.7 Sound pressure level (dB_A) of ambient noise on the site during measurement.

9.8 The temperature and relative humidity of the air if these measurements were taken.

Appendix A

(Normative Appendix)

Illustrations showing the clearance to leave, the position of the microphone in relation to the vehicle, the exhaust pipe to choose for the measurements and the position of the measurement point on the exhaust pipe.

Figure A.1: Clearance to leave around the vehicle and microphone

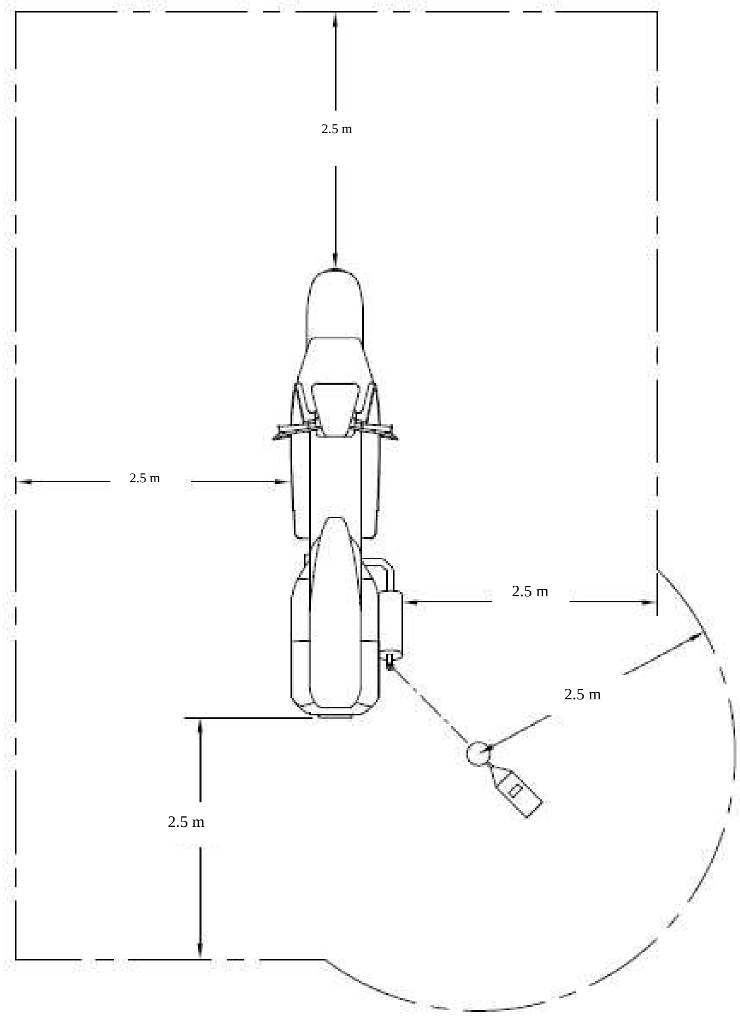
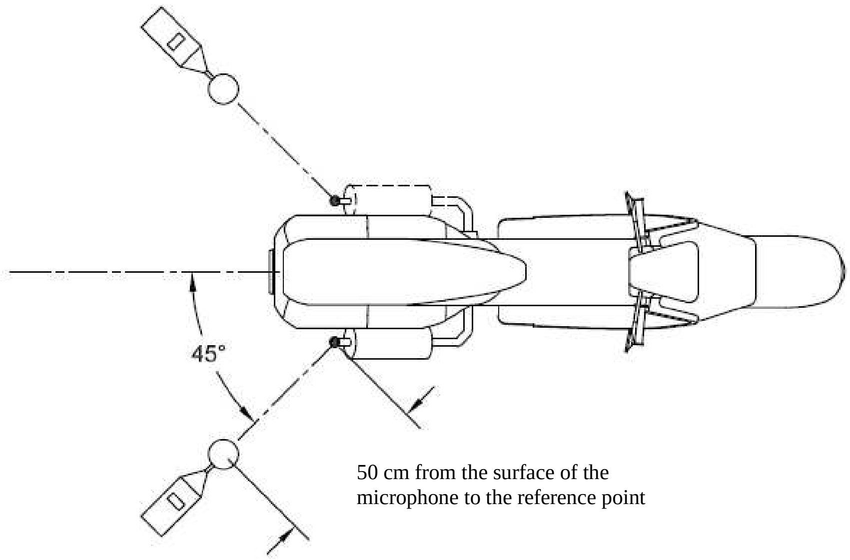
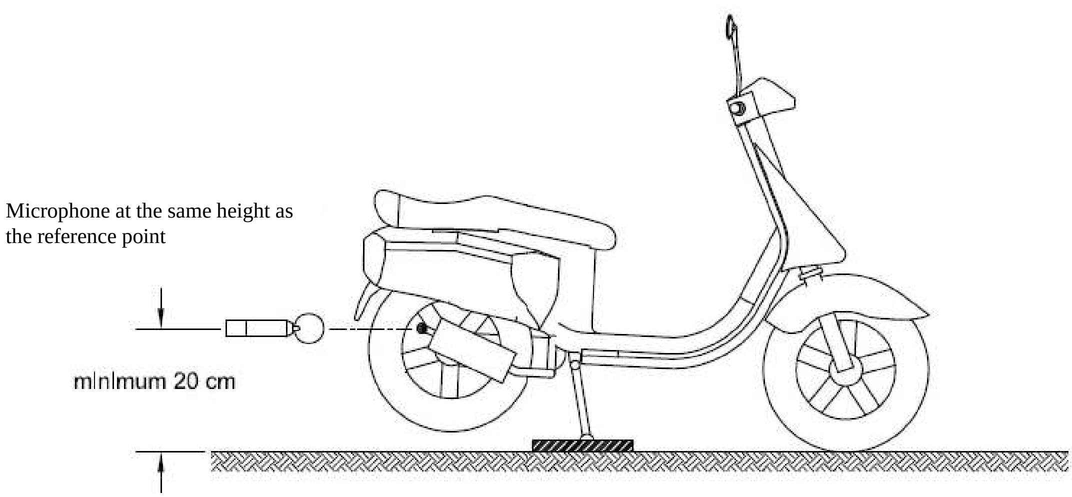


Figure A.2: Position of the microphone in relation to the exhaust pipe





Scooter type vehicles are normally equipped with a single exhaust pipe. If this is not the case, refer to the selection rules for motorcycles that are reproduced here.

In general, choose the rearmost exhaust pipe. When two exhaust pipes are in approximately the same position, choose the lower one. The second exhaust pipe must not be less than 50 cm from the microphone.

Figure A.3: Exhaust pipes to choose when there are several pipes on the same side

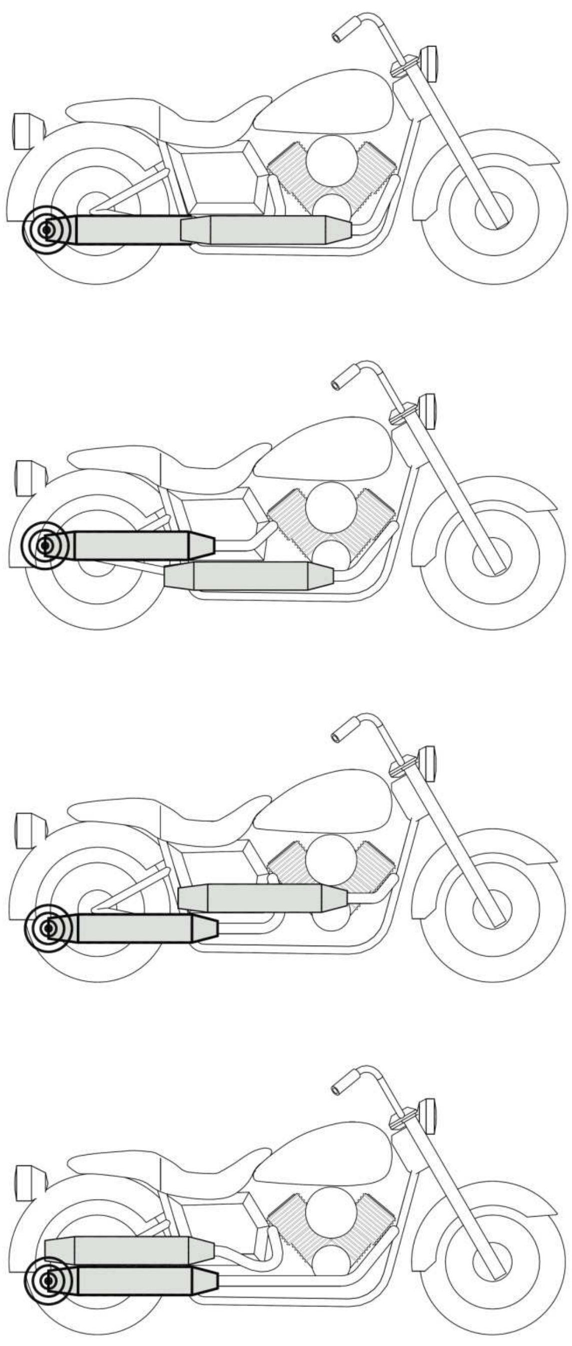
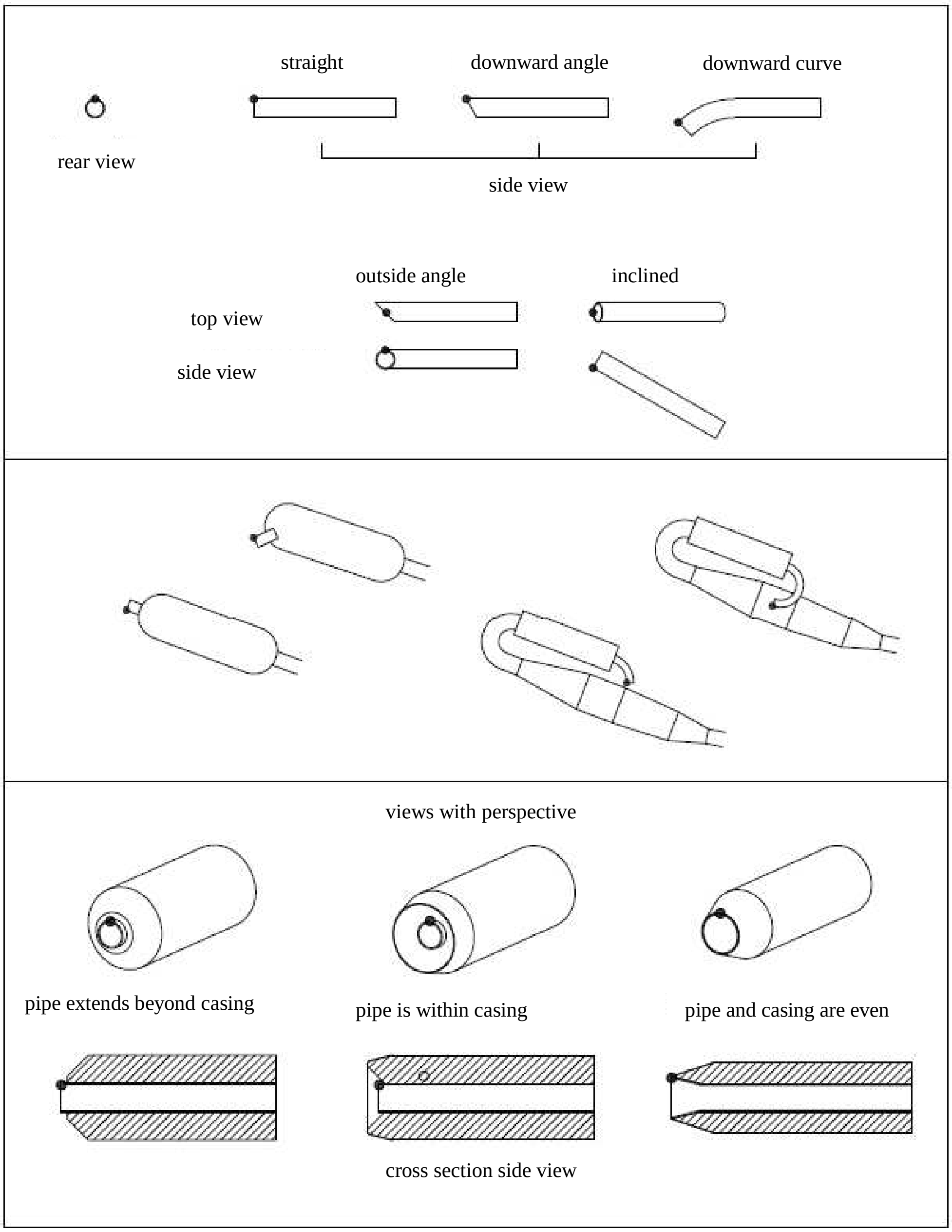


Figure A.4: Reference point to use on exhaust pipes to measure distances

As a general rule, the reference point to be used is the highest point on the edge of the exhaust pipes, above the centre of the exhaust opening (see *Rear view*), without taking into account the casing around the exhaust pipe itself. The reference point must be chosen so that the centre of the pipe opening is not less than 50 cm from the microphone.



Appendix B – Alternative Test Methods

(Normative Appendix)

This Appendix gives two alternative methods for cases where the constant engine rpm method described in section 6.2 cannot be used. Section B.1 presents the variable engine rpm method to be used when it is impossible to maintain a stable constant engine rpm. Section B.2 details the idle engine rpm method to use when the variable engine rpm method described in Section B.1 does not give conclusive results.

B.1 Tests with variable engine rpm

This test must be conducted only when the test with constant engine rpm (Section 6.2) cannot be conclusively performed.

B.1.1 Start the measurement of the sound pressure level when the vehicle's engine is idling and set the sound level meter so that it takes a continuous measurement until the end of the test.

B.1.2 Starting with the engine idling, gradually increase the engine rpm to the prescribed level, without exceeding the maximum determined limit. The increase in rpm must take at least 2 seconds. Then gradually reduce engine speed.

B.1.3 Stop the sound meter measurement. Note the maximum sound pressure level reached during the measurement (LAF_{MAX}).

B.1.4 If the measurement obtained is 2 dB_A or less than the allowed limit or greater than this limit, take a second measurement[5]. The maximum difference between the two measurements must be no more than 1.0 dB_A for the test to be considered valid. Let the engine idle between the two measurements.

If it is impossible to obtain this level of accuracy after several measurements, use the test with the engine idling (Section B.2).

B.1.5 The result of the measurements is the maximum sound pressure level LAF_{MAX} if only a single measurement is taken (Section B.1.3) or the maximum value of the two measurements if two measurements are taken (Section B.1.4). The result is rounded off to the closest 0.1 dB

B.1.6 Interpretation of the results is carried out in accordance with the procedures in Section 8.

[5] It is recommended, but not required, that the calibration be checked between the two measurements in order to ensure that they are valid. If the verification of the sound level meter shows a difference of more than 0.5 dB in relation to the last verification, calibrate or adjust the meter and carry out the two measurements again.

B.2 Tests with the engine idling

This test must be carried out only when the test with variable engine rpm (Section B.1) could not be conclusively performed.

B.2.1 Let the engine idle.

B.2.2 Measure the sound pressure level. The measurement must be taken for a minimum of 1 second. The LAF_{MAX} during this 1-second period is the sound pressure level emitted by the exhaust pipe while the engine is idling.

B.2.3 If the measurement obtained is 2 dB_A or less than the allowed limit (see Section B.2.5) or greater than this limit, take a second measurement[6]. The maximum difference between the two measurements must be no more than 1.0 dB_A for the test to be considered valid.

B.2.4 The result of the measurements is the maximum sound pressure level LAF_{MAX} if only a single measurement is taken (Section B.2.2) or the maximum value of the two measurements if two measurements are taken (Section B.2.3). The result is rounded off to the closest 0.1 dB_A.

B.2.5 The limits to comply with during a road check and the enforcement of laws and regulations on noise levels are:

Prescribed limit for mopeds and scooters tested with engine idling	**82 dB_A**
Prescribed limit for motorcycles tested with engine idling	**92 dB_A**

[6]It is recommended, but not required, that the calibration be checked between the two measurements in order to ensure that they are valid. If the verification of the sound level meter shows a difference of more than 0.5 dB in relation to the last verification, calibrate or adjust the meter and carry out the two measurements again.

Appendix C – Technical Information
(Informative Appendix)

C.1 Definition of sound pressure level and decibel (dB)

Sound pressure level is defined by the following mathematical equation:

$$L_p = 10\log\left(\frac{p}{p_{ref}}\right)^2 = 20\log\frac{p}{p_{ref}}$$

where *p* is the pressure of the sound wave and p_{ref} is the reference pressure and equals 2 x 10 -5 Pa (20 µPa). The reference pressure corresponds to a just perceptible sound level at a frequency of 1000 Hz. The letter *L* used to represent the sound pressure level corresponds to “Level”. The subscript P indicates the pressure level. This subscript is often omitted.

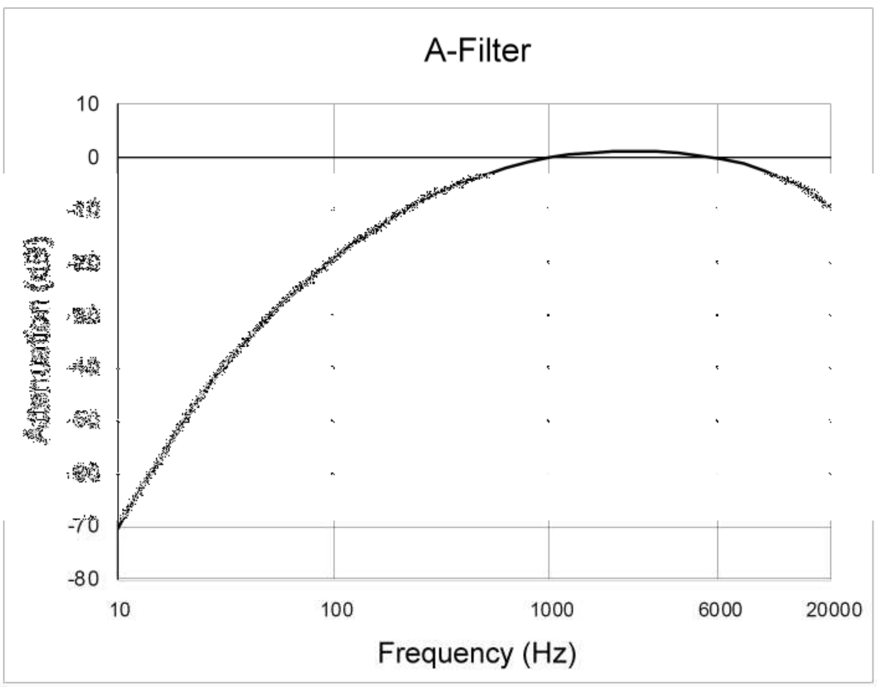
The base unit is the Bel. This unit indicates that we use the logarithm to express the result. In order to facilitate reading the results, in practice we use the decibel (dB), just as we use centimeters rather than metres for short lengths. The sound scale goes from 0 dB to approximately 140 dB. A sound on the hearing threshold would have 0 dB level. The pain and hearing loss threshold is at 140 dB. There must be a difference of approximately 1 dB between two sounds to perceive that one is louder than the other. The following table gives some typical examples:

dB	
140	Pain threshold
120	Jet take-off at 500 m
100	Pneumatic hammer, siren, lawnmower
80	Car at 15 m, busy street
60	Offices, outside ambient noise (quiet neighbourhood)
40	Library, private office
20	Rustling leaves at 20 m (very light wind)
0	Hearing threshold

The sound pressure level differs from sound power and sound intensity, which are quantities also expressed in decibels.

C.2 Response expressed as frequency in the range of human hearing

The human ear can perceive sounds from 16 Hz up to 16 kHz (a hertz is one oscillation per second). The ear responds differently to sound pressure depending on frequency. At low frequencies and high frequencies, the same sound pressure seems weaker than at a mid-range frequency. To reproduce this effect, a frequency-weighting is applied to modify the sound and make it comparable to what is heard before calculating sound pressure level. The weighting that corresponds to human hearing for sounds of weak intensity, with as a basis of comparison a sound of 40 dB at 1000 Hz, is called an A frequency-weighting. This weighting is conducted using a filter. Use of the letter A in the name of the variable sound pressure level (LAF, LAS, L_{Aeq}) or in units (dBA, dB_A) makes direct reference to the fact that the sound is weighted with an A-filter. This frequency-weighting is widely used. The figure below shows the attenuations (negative values) of the A-filter, with the 1000 Hz (1 kHz) frequency as reference.



C.3 Addition of decibels

The total sound pressure level, in decibels, resulting from the sum of two independent sound sources is calculated with the following formula:

$$L_{tot} = 10\log\left(10^{L_1/10} + 10^{L_2/10}\right)$$

where L_1 and L_2 are sound pressure levels, in decibels, from the two sources.

The following table makes it easy to calculate the sum of the two sources starting from the difference (L1 – L 2) of sound pressure level between the two sources. The source with the highest sound level is L_1. The total level is calculated with:

$$L_{tot} = L_1 + \Delta$$

$L_1 - L_2$ (dB)	0	1	2	3	4	5	6	8	10	15	20	25
Δ (dB)	3.01	2.54	2.12	1.76	1.46	1.19	0.97	0.64	0.41	0.14	0.04	0.01

Example: Addition of two sources whose levels are L_1 = 90 dB_A and L_2 = 88 dB_A.

According to the table, for a difference of 2 dB, Δ = 2.12 dB;
The total is therefore L_{tot} = 90 + 2.12 = 92.12 dB_A.

C.4 Influence of ambient noise

When taking the measurement, ambient noise acts as a second sound source. The addition rule above applies. The required difference of 10 dB_A between the level measured and the background noise ensures that the latter does not contribute more than 0.41 dB_A of the value measured.

C.5 Variation in sound pressure level with distance

By moving away from the sound source, the energy of the pressure waves is scattered and the result is a decrease in the sound pressure level. For a point source, we observe a decrease of 6 dB when the distance is doubled. Close to a motorcycle, the decrease of the sound pressure level is in the order of 4 dB when the distance is doubled.

C.6 Certification of devices

The compliance of sound level meters with the requirements of the IEC 61672-1: 2002 standard or those of the ANSI S1.4-1983 (R2006) standard, as well as compliance with acoustic calibrators with the IEC 60942: 2003 standard or those of the ANSI S1.40-2006 standard must be checked by the existence of a valid compliance certificate. The tests of compliance verification must have been conducted during the 24 months preceding the use of the device in the case of sound level meters and during the 12 last months in the case of acoustic calibrators. All the compliance tests of devices must be carried out in a laboratory authorized to conduct traceable calibrations.

C.7 Characteristics of sound level meters

A sound level meter is a device with a microphone, a set of electrical circuits for amplification and processing of the signal received (analog processing) or devices for digital processing and computation of specific quantities, as well as a means of displaying results.

Sound meters have different frequency-weightings (A, C, Z), different time-weightings (F, S) and different measurement modes. This section describes some of these characteristics.

Frequency-weighting can modify sound to reproduce different hearing characteristics. The A frequency-weighting reproduces human hearing, as presented in section C.2. The C frequency-weighting is approximately flat between 63 and 4000 Hz. In particular, we use the C weighting to measure peak sound pressure levels and to specify hearing protection. The Z frequency-weighting (also called flat or linear weighting) leaves the sound unchanged.

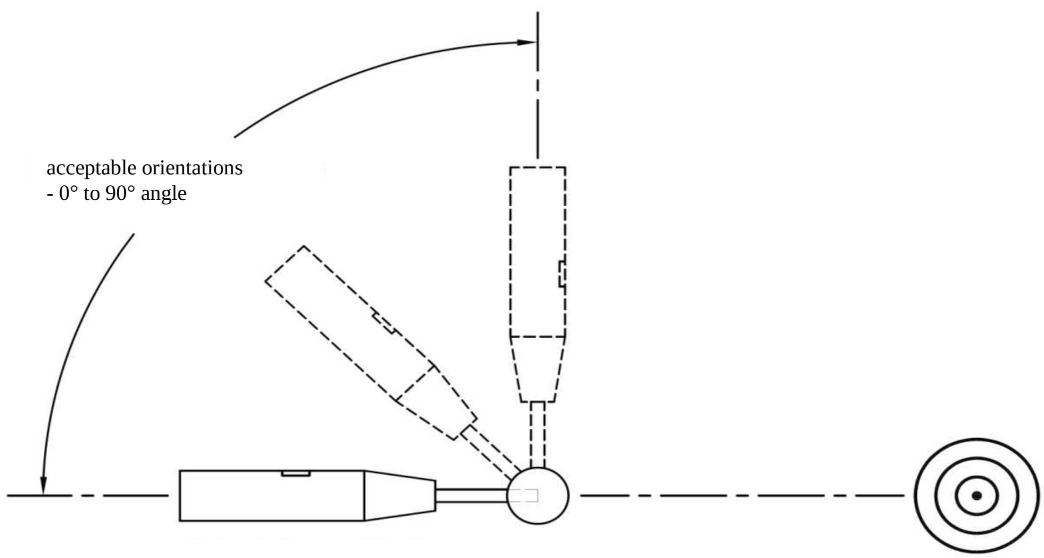
The time-weightings are used to smooth out instantaneous fluctuations of sound signals by applying an exponential filter in order to facilitate readings on the devices. The S time-weighting (Slow) uses a time constant of 1 second and is useful when average estimation of fluctuating sound is wanted. For example, it is used to measure noise doses. The F time-weighting (Fast) uses a time constant of 0.125 seconds. This time constant makes it is easier to follow the sound fluctuations than with the S weighting. We generally use the F weighting to measure noise from vehicles, machinery, etc.

Lastly, different measurement modes are available on the devices. Continuous display (including SPL mode) gives a reading of the instantaneous, average or maximum value, based on the device or setting chosen, with a refresh rate of 0.5 to 1 second. The value can be weighted (A, C, Z, and F or S). Users often choose the S weighting to reduce variations of the display, but this results in modification of the value measured when the sound is very variable (smoothing effect). Most of the devices also offer memorization of maximum and minimum values produced during a given period. The LAF_{MAX} value, for example, is the maximum sound pressure level measured by the device with the A frequency-weighting and F time-weighting. The measurement period can be set. This value is often used to measure noise from vehicles and machines. In the same way, you can obtain a measurement of the average value during a given period. This measurement is called the equivalent sound pressure level and is usually weighted A and F, L_{Aeq}. These weightings let the user take into account point noise or noise that varies widely during the measurement period. This measurement is often set to the equivalent of a constant noise for one second for comparison purposes and application of standards. A last current mode measures the peak instantaneous sound pressure level (or peak value). This measurement is not time-weighted (no smoothing) and is C weighted: $L_{C\ peak}$. This measurement must not be confused with LAF_{MAX}. $L_{C\ peak}$ can easily be greater than LAF_{MAX} by 20 to 30 dB_A.

C.8 Orientation of the microphone axis

The two types of microphones used with sound level meters (free field and random incidence) differ in their design and how they are used. Free-field microphones are designed for measurements where there is no reverberation (outside in a clear space, inside an anechoic chamber). Random incidence microphones are designed for measurements in a reverberating sound field or a sound field with multiple sources (factory, room with reverberation). The two types of microphones are omnidirectional. Their response is flat for frequencies below 3 kHz and when the axis of the microphone is between 0° and 90° with respect to the target. Sound emissions from motorcycle exhaust pipes are 90% due to their frequency content of less than 3 kHz. Accordingly, the axis of the microphone does not need to be perfectly aligned with the target.

Given the characteristics of the microphones, whether they are free field or random incidence, and given the characteristics of sound emissions from motorcycle exhaust pipes, the axis of the microphone does not need to be perfectly aligned with the target.



C.9 Measurement uncertainty

Factors that influence the precision of measurements by adding some variability to the measurement process are called measurement uncertainty. Under the ISO 5130 standard, measurement uncertainty for the type of measurements described in this standard is less than 1.9 dB.