The Engineering Society
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SAE J1287 JUN88

Measurement of Exhaust Sound Levels of Stationary Motorcycles

SAE Standard
Revised June 1988

Submitted for Recognition as an American National Standard

The Engineering Society For Advancing Mobility Land Sea Air and Space ®
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SPECIALIZED VEHICLE STANDARD

Submitted for recognition as an American National Standard

SAE J1287

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Superseding J1287 MAR82

Ø MEASUREMENT OF EXHAUST SOUND LEVELS OF STATIONARY MOTORCYCLES

1. SCOPE:

This document establishes the test procedure, environment, and instrumentation for determining the sound levels of motorcycles under stationary conditions. This test will measure primarily exhaust noise and does not represent the optimum procedure for evaluating total vehicle noise. For this purpose, SAE J331 or SAE J47 is recommended.

2. DEFINITIONS:

2.1 Field Calibration: Calibration of the sound level meter using an external sound level calibrator, an internal calibration means, or any other method which will ensure the accuracy of sound level meter readings.

2.2 Longitudinal Plane of Symmetry: As defined in SAE J213a.

2.3 Rated Engine Speed: The engine speed in revolutions per minute at which the engine delivers its maximum Net Brake Power as defined in SAE J1349, as determined by the manufacturer.

3. INSTRUMENTATION:

The following instrumentation shall be used:

3.1 A sound level meter meeting the Type 1, Type S1A, Type 2, or Type S2A requirements of American National Standards Institute Specification for Sound Level Meters, S1.4-1983.

3.1.1 As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or other indicating instrument, provided the system meets the requirements of SAE J184.

3.2 A sound level calibrator with an accuracy of ± 0.5 dB (see paragraph 6.9).

3.3 A windscreen which does not affect microphone response more than ± 1dB for frequencies of 63-4000 Hz and ± 1.5 dB for frequencies of 4000-10 000 Hz.

3.4 An engine speed tachometer or other means of determining engine speed, with a steady state accuracy of ± 3% at the test speed.

3.5 An anemometer with steady state accuracy of ± 10% at 9 m/s (20 mph).

4. TEST SITE:

4.1 The test site shall be a flat, open surface free of large sound reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings, or hillsides located within 5 m (16 ft) of the motorcycle being tested and the location of the microphone.

4.2 The surface of the ground within the area described in paragraph 4.1 shall be paving or hard packed earth, level within an average slope of 40 mm-m (0.5 in-ft), and shall be free of loose or powdered snow, plowed soil, grass of a height greater than 150 mm (6 in), trees, or other extraneous material.

5. PROCEDURE:

5.1 A rider shall sit astride the motorcycle in normal riding position with both feet on the ground. If this is not possible because of the seat height of the motorcycle, and for three-wheeled motorcycles, the rider shall sit in the normal riding position with one or both feet on the footrests. If necessary, an assistant may hold the motorcycle by the forks, front wheel, or handlebars so that it is stationary with its longitudinal plane of symmetry vertical. In the alternative, the rider may use a box, rock, or other object to rest his feet upon to steady the motorcycle, so long as the motorcycle longitudinal plane of symmetry is vertical and stationary.

The rider shall run the engine with the gearbox in neutral at a speed equal to one-half of the rated engine speed.

5.1.1 If no neutral is provided, the motorcycle shall be operated either with the rear wheel(s) at least 50 mm (2 in) clear of the ground or with the drive chain or belt removed, or with the clutch, if the motorcycle is so equipped, disengaged.

5.2 The engine of the motorcycle under test shall be at normal operating temperature during the test.

6. MEASUREMENTS:

6.1 The sound level meter shall be set for the A-weighing network and should be set for slow dynamic response. (See Appendix, paragraph A.5.)

6.2 Tests shall be made on each side of the motorcycle having an exhaust outlet.

6.3 The microphone shall be located beind, 0.5 ± 0.01 m (20 ± 1/2 in) from, and within 0.01 m (1/2 in) of the same height as, the exhaust outlet and at a 45 ± 10 deg angle to the normal line of travel of the motorcycle. If there is more than one exhaust outlet per side, the microphone shall be located with reference to the rearmost outlet.

The longitudinal axis of the microphone shall be in a plane parallel to the ground plane. The axis of the microphone shall be oriented as specified for free field response by the manufacturer. (See Fig. 1.)

6.4 No wire or other rigid means of distance measurement shall be attached to the sound measuring system.

6.5 The sound level recorded shall be that measured during steady state operation at the engine speed (± 200 rpm) determined in Section 5 measured on the loudest side of the motorcycle (if outlet located on both sides - see paragraph 6.2). The test speed in rpm shall also be recorded.

6.6 The ambient sound level (including wind effects) at the test site due to sources other than the motorcycle being measured shall be at least 10 dB lower than the sound level produced by the motorcycle under test.

6.7 Wind speed at the test site during the test shall be less than 9 m-s (20 mph).

6.8 While making sound level measurements, not more than one person other than the rider, the measurer, and the assistant (if necessary) (see paragraph 5.1) shall be within 3 m (10 ft) of the motorcycle under test or the microphone, and that person shall be directly behind the measurer on a line through the microphone and the measurer.

6.9 Calibration of the sound level meter using the sound level calibrator (see paragraph 3.2) shall be made immediately before the first test of each test day and should be made at the end of each test day. Field calibration should be made at intervals of no more than 1 hour.

7. GENERAL COMMENTS:

7.1 It is essential that persons conducting the test be knowledgeable of the test procedure and use of the instrumentation.

7.2 Proper use of all test instruments is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to, for both recommended operation of the instrument and precautions to be observed.

7.3 Specific Items for Consideration:

7.3.1 The type of microphone, its directional response characteristics, and its orientation relative to the source of sound.

7.3.2 The effects of ambient weather conditions on the performance of all instruments (that is, temperature, humidity, and barometric pressure).

7.3.3 Proper acoustical calibration procedure to include the influence of extension cables, etc.

7.4 Although either Type 1 or Type 2 sound level meters may be used with this procedure, it is suggested that a Type 1 instrument be considered as it generally has lesser overall tolerance which can result in more accurate measurements.

7.5 The use of the word "shall" in the procedure is to be understood as obligatory. The use of the word "should" is to be understood as advisory. The use of the word "may" is to be understood as permissive.

8. REFERENCES:

1. SAE J47 JUN86, Maximum Sound Level Potential for Motorcycles.
2. SAE J184 AUG87, Qualifying a Sound Data Acquisition System
3. SAE J213a, Definitions - Motorcycles
4. SAE J331 MAY87, Sound Levels for Motorcycles.
5. SAE J1349 JUN85, Engine Power Test Code-Spark Ignition and Diesel
6. ANSI S1.4 - 1983 Specification for Sound Level Meters

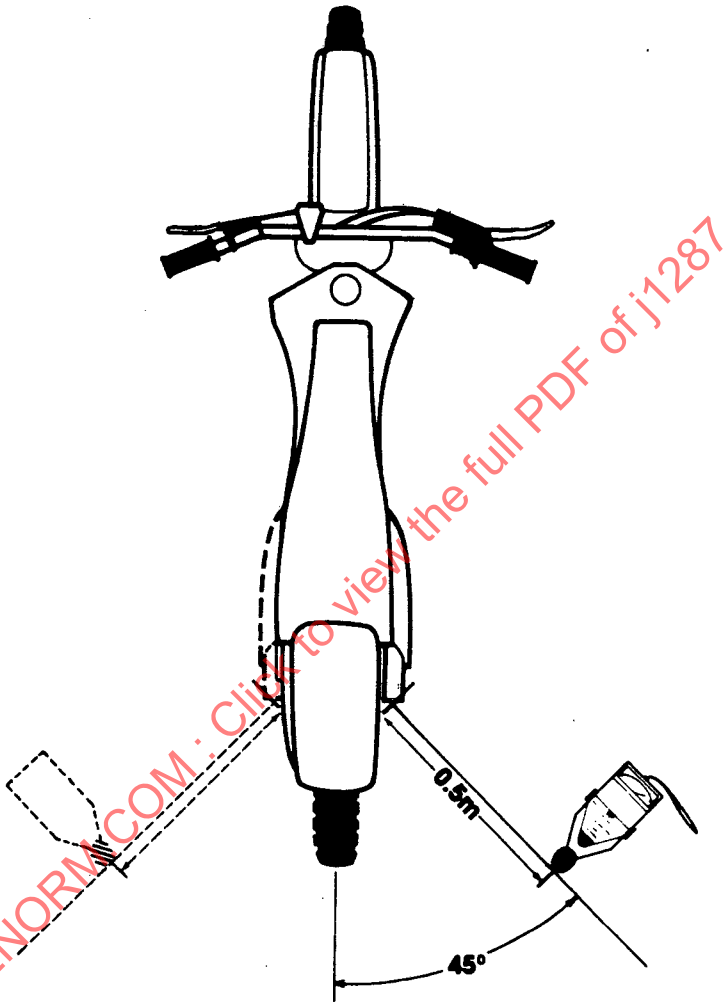

FIGURE 1

Appendix

This procedure can be adapted to a variety of uses, which may include exhaust system certification, enforcement of in-use motorcycle standards, and use by motorcycle competition bodies to ensure some silencing of race vehicles. As provided in paragraph 6.1.14 of SAE J1159 JUN86, this Appendix adds supplementary engineering reference data and educational material and is not an integral part of the basic technical report. Accordingly, test results obtained using the variations provided in this Appendix shall be reported with the results of all tests conducted. Such results shall not be reported as having been obtained according to the standard conditions of this document. Some of these uses may require less precision than is called for in the procedure. Accordingly, the following changes may be made for convenience with the realization that accuracy may suffer.

A.1 Enforcement Testing: When used for enforcement, this procedure is intended to be a pass-fail test. A ± 1.5 dB variation due to changes in test conditions, motorcycles, and instruments can occur. Test to test variations within this limit shall be considered acceptable. If limits are to be set according to this procedure, these variations should be considered when limits are chosen.

In enforcement situations, it is often easier to use one-half of the redline speed (redline speed - The lowest numerical engine speed included in the red zone on the motorcycle tachometer), rather than the test speed specified in paragraph 5.1. One-half of redline speed is a higher test speed than one-half of rated rpm; thus the measured sound level will be higher, and a 3 dB tolerance must be added to the applicable sound level limit.

While site tolerances may be relaxed somewhat without serious degradation of precision in the method, site parameters, as described in Section 4, should be as closely adhered to as possible. It is unlikely that useful results will be obtained if, for instance, any other motorcycle or other vehicle or person is within six feet of the test motorcycle, or if the motorcycle is tested while it is loaded in a pickup truck or on a trailer.

A.2 Instrumentation: Type 1 instrumentation, which generally can provide the most accurate measurements, should be used when the need for accuracy is great, such as certification of exhaust systems, or enforcement action which may result in some form of penalty.

Type 2 instrumentation could be appropriate for some enforcement work, such as a preliminary screening test, or for general data gathering. On the other hand, instrumentation which is less precise than Type 1 or Type 2 may be appropriate in cases such as at a racetrack or motorcycle park, when the primary interest is securing some noise reduction from the motorcycles operated within, and not measuring for the purpose of meeting specific maximum noise limits. Selection of equipment should reflect the need for accuracy (particularly considering any consequences) balanced against cost. Caution should be exercised, however, when selecting equipment which does not conform with ANSI standards. Experience with consumer electronic types of sound level meters indicates most such meters do not possess operating characteristics of sufficient accuracy or consistency to yield meaningful results. Meters which meet obsolete ANSI S1.4 Type 3 specifications, however, are sufficiently accurate for less demanding applications such as racetrack enforcement.

A.3 Procedure: When making comparison measurements where a single variable is to be evaluated, such as comparing the sound level of two different exhaust systems on the same vehicle, selection of the correct engine speed according to paragraph 5.1 is not critical as long as the same engine speed is used for each test.

A.4 Racing Motorcycles: This procedure may be used for sound testing of racing motorcycles. An appropriate test speed for both four-stroke and two-stroke high performance competition motorcycles for which the rated engine speed is not known is determined from the formula:

$$\text{Test Speed} = \frac{306\,000}{\text{stroke in millimeters}} \quad \text{or} \quad \left(\frac{12\,000}{\text{stroke in inches}}\right)$$

A.5 Dynamic Response: Use of slow dynamic response is specified, but fast dynamic response may be used. Because of the essentially constant nature of the sound level, either mode is acceptable; the meter is easier to read when slow response is used.

A.6 Wind Speed: If it is not possible to delay testing until the specified wind conditions prevail, testing can be performed in higher winds. In this case, the motorcycle should be positioned so that the prevailing wind direction is parallel to the normal direction of travel of the motorcycle.

A.7 Alternate Engine Speed: If the rated engine speed for a particular motorcycle is unknown, then the test speed shall be calculated from one of the following formulae:

For four-stroke engines: $\frac{250\,000}{\text{stroke in millimeters}}$ or $\left(\frac{9800}{\text{stroke in inches}}\right)$

For two-stroke engines: $\frac{200\,000}{\text{stroke in millimeters}}$ or $\left(\frac{7900}{\text{stroke in inches}}\right)$

The phi (Ø) symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

RATIONALE:

2. Adds Definitions heading.

3.5 Change anemometer specification to conform with SAE J331 and J47.

4.2 ANSI Committee S12 suggests deleting the height of the grass, that is, precluding testing on any grass. I cannot agree with this - in the East, there is grass on virtually all potential test sites.

5.1 To allow for newer, taller, designs in which the normal rider cannot reach the ground with his feet.

Also, moves alternative engine speed calculation formulae to Appendix A.7.

5.1.1 Adds a provision that testing may be done with clutch pulled in.

A.1 Adds caution regarding not testing with bike on truck or trailer.

A.2 Eliminates Type 3 per ANSI S12.

A.4 These formulae result in somewhat higher test engine speeds than those suggested by the formula of Section A.7. This test philosophy is based on the subcommittee's experience that racing bikes run at higher engine speed than road bikes, and that testing racers, which in many cases have no defined "red line" because of engine modifications, at the lower speeds of Section A.7 grossly underestimates their noise-making potential.

A.7 Engine speed formulae are moved to here. The old version contained the following language:

If no such speed is published for the particular motorcycle, then the test speed shall be calculated from one of the following formulae:

For four-stroke engines: $\frac{250\ 000}{\text{stroke in millimeters}}$ or $\left(\frac{9800}{\text{stroke in inches}}\right)$

For two-stroke engines: $\frac{200\ 000}{\text{stroke in millimeters}}$ or $\left(\frac{7900}{\text{stroke in inches}}\right)$

These formulae were derived by correlating stroke with rated rpm published for a number of motorcycles in 1979. Since that time, the model, size, and rated rpm mix of the motorcycle population may have changed, but the committee is aware of no firm evidence of this. Thus, these formulae are continued in this revision. However, at the suggestion of several subcommittee members, their use is de-emphasized by removing them to the appendix.