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Sound Levels for Motorcycles

SAE Recommended Practice
Revised May 1987

Submitted for Recognition as an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

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SPECIALIZED VEHICLE PRACTICE

Submitted for recognition as an American National Standard

SAE J331

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SOUND LEVELS FOR MOTORCYCLES

1. SCOPE: This SAE Recommended Practice establishes the test procedure, environment and instrumentation for determining the sound levels of motorcycles under full throttle acceleration and closed throttle deceleration.

2. DEFINITIONS:

2.1 Manual Transmission: A transmission having multiple discrete gear ratios which are individually selectable by the vehicle operator.

2.2 Automatic Transmission: A transmission which does not have multiple discrete gear ratios individually selectable by the vehicle operator.

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 JUN85, Engine Power Test Code--Spark Ignition and Diesel, as determined by the manufacturer.

2.4 Longitudinal Plane of Symmetry: As defined in SAE J213a, Definitions--Motorcycles

3. INSTRUMENTATION:

3.1 The following instrumentation shall be used where applicable:

3.1.1 A sound level meter which meets the Type 1 or Type S1A requirements of American National Standard Specification for Sound Level Meters, S1.4-1983. 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 that the system meets the requirements of SAE J184 MAR85, Qualifying a Sound Data Acquisition System.

3.1.2 An acoustic calibrator with an accuracy of ±0.5 dB (See paragraph 8.6.4).

3.1.3 An engine speed tachometer, or other means of determining engine speed, with a steady-state accuracy of ±3% at 60% and 100% of rated engine speed.

3.1.4 A speedometer with steady-state accuracy of ±3% at a vehicle speed of 50 km/h (31 mph).

3.1.5 An anemometer with steady-state accuracy of ±10% at a wind speed of 5.5 m/s (12 mph).

3.1.6 An acceptable windscreen may be used with the microphone. To be acceptable, the screen shall not affect the microphone response more than ±1 dB for frequencies of 4000 - 10 000 Hz, taking into account the orientation of the microphone.

4. TEST SITE:

4.1 The test site (Fig. 1) shall be a flat open space accommodating a straight vehicle path and the following points:

On the vehicle path -

(A) The microphone target point.

(B) Acceleration point - a point 7.5 m (24 ft 7 in) prior to the microphone target point.

(C) End point - a point 30 m (98 ft) beyond the microphone target point.

(D) A point 15 m (49 ft 2 in) prior to the microphone target point.

(E) A point 15 m (49 ft 2 in) beyond the microphone target point.

Off the vehicle path -

(F) Microphone point - a point 15 m (49 ft 2 in) from the vehicle path on the perpendicular line which passes through the microphone target point.

4.2 The measurement area (G) within the test site shall be a triangular area defined by the microphone point (F) and the points D and E. The surface of the ground within the measurement area shall be Portland cement or bituminous asphalt concrete, dry and free from snow, soil, or other extraneous material.

4.3 The test site shall be free of large sound reflecting surfaces (other than the ground) such as parked vehicles, signboards, buildings or hillsides, located within 30 m (98 ft) of the measurement area.

4.4 The vehicle path shall be on relatively smooth Portland cement or bituminous asphalt concrete, dry and free of extraneous material such as gravel, snow or ice and of sufficient length for acceleration, deceleration and stopping of the vehicle. (See paragraph 6.1.4)

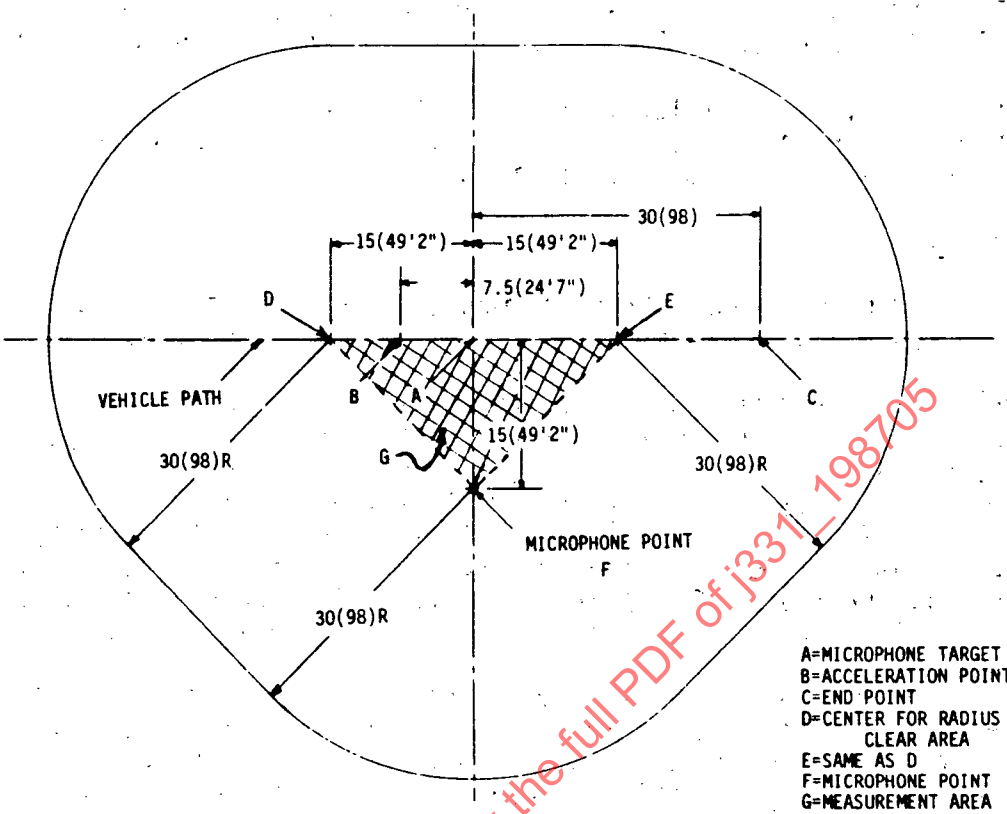

FIG. 1

4.5 The microphone of the sound level measurement system shall be located above the microphone point. The microphone shall be positioned 1.2 + 0.02 m (3 ft 11 1/4 in + 3/4 in) above the ground plane. The microphone's reference axis shall be perpendicular to the vehicle path. (Also see paragraphs 8.6 and 8.6.1)

4.6 The test site layout in Fig. 1, for purposes of clarity, illustrates an approach from left to right. Sound level measurements are to be made on both sides of the vehicle; therefore, it will be necessary to establish either a sound microphone location on the opposite side of the vehicle path with a corresponding clear area, or to use approaches from both directions with corresponding acceleration points and end points.

5. TEST MASS:

5.1 At the start of the test series, the vehicle shall be filled with fuel to not less than 75% capacity and other fluids to a nominal, full capacity.

5.2 The combined mass of the test rider and test equipment used on the vehicle shall be not more than 90 kg (198.5 lb) or less than 75 kg (165.4 lb).

If necessary, the vehicle/rider shall be laden with additional mass to compensate for any difference between the actual driver/equipment mass and the required 75 kg (165.4 lb) minimum.

6. PROCEDURE:

6.1 The following test shall be performed with sufficient runs (See paragraph 7.4) to establish maximum sound levels under acceleration:-

6.1.1 Vehicles with manual transmissions shall proceed along the vehicle path in second gear at a constant approach speed which shall correspond to an engine speed of 60% of rated engine speed or a speed of 50 km/h (31 mph) whichever is slower. When the front of the vehicle reaches the acceleration point, the throttle shall be rapidly and fully opened to accelerate the motorcycle along the vehicle path until the front of the vehicle reaches the end point, or until rated engine speed is reached, at which time the throttle shall be rapidly and fully closed.

6.1.2 Vehicles with automatic transmissions shall use a standing start procedure. The front of the vehicle shall be at the acceleration point and with the transmission in the lowest selectable range, the throttle shall be rapidly and fully opened to accelerate the motorcycle along the vehicle path, until the front of the vehicle reaches the end point, or until rated engine speed is reached, at which time the throttle shall be rapidly and fully closed.

6.1.3 The maximum engine speed attained during each run shall be recorded.

6.1.4 Wheel slip or front wheel lifting which affects the maximum sound level shall be avoided.

6.2 Unless it is apparent that maximum noise occurs under acceleration, the following test shall be performed with sufficient runs to establish maximum sound levels under deceleration:

6.2.1 For the test under deceleration, the vehicle shall approach the end point from the reverse direction in the gear used and at the average maximum engine speed attained in the test under acceleration. When the front of the vehicle reaches the end point, the throttle shall be rapidly and fully closed and the vehicle allowed to decelerate along the vehicle path until one half of rated engine speed or the point 15 m (49 ft 2 in) past the microphone target point is reached, whichever comes later.

6.3 Before measurements begin, sufficient preliminary runs shall be made to familiarize the rider with the vehicle and to allow the engine to reach normal operating temperature. The engine temperature shall be within the normal operating range prior to each run.

6.4 The longitudinal plane of symmetry of the test vehicle shall remain on the Ø vehicle path for all test runs.

Ø 7. MEASUREMENTS:

7.1 The sound level meter shall be set for fast response and for the A-weighting network.

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

7.3 Measurements shall be made only when the wind speed is below 5.5 m/sec (12 mph).

7.4 The following measurements shall be made for both the acceleration and, if conducted, deceleration test modes:

7.4.1 Measurements shall be taken for both sides of the vehicle.

7.4.2 The meter shall be observed during each test as the vehicle is accelerating and decelerating. The highest sound level observed for each side during each test run shall be recorded.

7.4.3 Sufficient test runs shall be made until at least 4 recorded measurements Ø for each test mode and each side of the vehicle are within a 2 dB range. The sound level for that side and test mode shall be the arithmetic average for the first four measurements within a 2 dB range.

7.5 The sound level reported for the vehicle shall be the sound level of the side and test mode with the highest average sound level.

8. GENERAL COMMENTS:

8.1 Technically competent personnel should select the equipment, and the test should be conducted only by trained and experienced persons familiar with the current techniques of sound measurement.

8.2 While making sound level measurements, not more than one person other than the rider and the observer reading the meter shall be within 15 m (49 ft 2 in) of the vehicle or microphone. The additional person shall be directly behind the meter observer on a line through the microphone and the observer.

8.3 The test rider should be fully conversant with and qualified to ride the machine under test, and be familiar with the test procedure.

8.4 It should be noted that error in the engine speed indicator as well as error due to operator response time may result in sound level measurement error.

8.5 Tachometers having steady-state accuracy within 3% of actual engine speed at 60% and 100% of the rated engine speed are commercially available and are included on some motorcycles as original equipment. This class of tachometers is regarded as being sufficiently accurate for general sound level measurements. In circumstances where very accurate sound level measurements are necessary, accurate engine speed determination is essential, and consideration must be given to the accuracy and response time of the engine speed measurement system. Special care must be taken not to exceed rated engine speed. Exact engine speed measurement must be based on the time interval for not less than one complete engine cycle; for example, two crankshaft revolutions for a four-stroke engine.

8.6 Proper use of all test instrumentation is essential in obtaining 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. Specific items to be considered are:

8.6.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

8.6.2 The effects of ambient weather conditions (for example, temperature, humidity, and barometric pressure) on the performance of all instruments.

8.6.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

8.6.4 Proper acoustical calibration procedures, including the influence of extension cables, etc., shall be followed. Field calibration shall be made immediately before and after the test series described in paragraph 7.4.3. Internal calibration is acceptable for field use, provided that external calibration is accomplished immediately before or after field use.

9. REFERENCES:

9.1 SAE J184 MAR85, Qualifying a Sound Data Acquisition System.

9.2 SAE J1349 JUN85, Engine Power Test Code - Spark Ignition and Diesel.

9.3 SAE J47 JUN86, Maximum Sound Level Potential for Motorcycles.

9.4 SAE J213a, Definitions - Motorcycles.

9.5 American National Standards Institute, S1.4-1983, Specification for Sound Level Meters.

RATIONALE:

The proposed amendments to this procedure include both stylistic and substantive changes. The Motorcycle Sound Level Subcommittee has elected to make the following changes:

Section 1.

The wording of the scope has been changed to more accurately reflect what is measured by this method.

Section 2.

This new section includes definitions for manual and automatic transmissions and rated engine speed. This will clarify the procedures in this document.

Paragraph 3.1.3 (was 2.1.3)

The requirements for a precision tachometer have been dropped because of the general unavailability of instruments that meet the old requirements. Most tachometers installed on a vehicle will meet the present specifications. The necessity of using a more accurate instrument under situations demanding great accuracy is addressed in Section 8.5.

Paragraph 3.1.4 (was 2.1.4)

The requirements for a speedometer to have a higher level of accuracy at the test approach speed is now specified.

Section 4. (was 3.)

Has been reworded and rearranged for clarity and consistency per R. Hillquist.

Sections 3. and 4.

The required precision of the instruments and linear measurements given in these sections is neither the most nor least precise that is possible. The intent is to use available equipment and procedures for performing these tests without degrading the accuracy or repeatability of the sound readings obtained. The specified accuracies for the instruments follows this intent. The location of the microphone is specified with given tolerances; other test site points are to be established in conformance with good engineering practice.

Paragraph 5.2 (was 4.2)

The acceptable test rider mass range has been expanded to accept riders as heavy as 200 pounds. This change was based on an evaluation of the effect of rider weight on acceleration sound level. The test indicated that an additional mass of 19 lb on each of 2 machines resulted in no difference in sound level. When tested with a rider and a 175 lb passenger, the sound level output ranged from 0 to 2 dB lower for the 8 motorcycles tested.

RATIONALE (Continued):

Paragraph 6.1

This is a combination of old Paragraphs 5.1 and 5.2 with several major changes. The old Paragraph 5.1 contained an involved procedure on gear selection to assure that the vehicle was at least 25 feet beyond the microphone target point when rated engine speed was reached. The new procedure requires all vehicles to be tested in 2nd gear. A test of dual-purpose and off-highway machines which normally use 3rd gear under J331a was conducted by the Subcommittee. Several procedures were tried in an effort to simplify the test and make it easier to perform. The use of 2nd gear for all machines with manual transmissions was selected because of its simplicity.

Based on data from 25 vehicles, 2nd gear at 60% maximum RPM produced an average of 1.2 dB increase in sound level, with the following distribution of sound levels when compared to J331a sound levels:

Range	Number of Vehicles
-1.0 to -0.6	1
-0.5 to -0.1	3
0.0 to 0.4	3
0.5 to 0.9	5
1.0 to 1.4	4
1.5 to 1.9	2
2.0 to 2.4	2
2.5 to 2.9	2
3.0 to 3.4	2
3.5 to 4.0	1
x = 1.2 dB	n = 25

Additionally, a new procedure has been added for testing vehicles with automatic transmissions. The shift point cannot be controlled on automatic transmissions (as defined in this document); therefore, the task force feels the standing start procedure is the best compromise. Suggestions and supporting data indicating this to be in error will be gratefully received.

Paragraph 6.2 (was 5.3)

The test for deceleration has become less discretionary with the new wording and the procedure has been described more completely.

Section 7. (was 6.)

The format of this section has been expanded for clarity. Also, the minimum number of test runs to be performed has been reduced from six to four, although the number of test runs used in the numerical analysis remains the same, at four.

Paragraph 8.5

This paragraph is an addition which points out the importance of using an accurate tachometer when more accurate sound level measurements are needed.