The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE J986 | REV. AUG94

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Superseding J986 OCT88

(R) SOUND LEVEL FOR PASSENGER CARS AND LIGHT TRUCKS

1. ***Scope***—This SAE Standard establishes the test procedure, environment, and instrumentation for determining the exterior sound level for passenger cars, multipurpose vehicles, and light trucks having a gross vehicle mass rating of 4540 kg or less. The test procedure is characterized by having fixed initial conditions, i.e., an as-specified initial vehicle speed and gear selection at a fixed start point on the test site. Full-throttle acceleration and closed-throttle deceleration of the vehicle are included in this procedure.

   Sound levels determined in accordance with this document are dependent on the performance capability of the test vehicle, as influenced by power-to-mass ratio and overall powertrain gear ratio.

2. ***References***

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J184—Qualifying a Sound Data Acquisition System
SAE J1349—Engine Power Test Code—Spark Ignition and Diesel

2.1.2 ANSI PUBLICATIONS—Available from 11 West 42nd Street, New York, NY 10036-8002.

ANSI S1.4-1983—Specification for Sound Level Meters
ANSI S1.4A-1985—Sound Level Meters

2.1.3 U.S. Environmental Protection Agency Noise Advisory Circular: A/C No. 3, January 27, 1978

2.2 Definitions

2.2.1 CURB MASS—The mass of the vehicle with standard equipment, optional equipment, and fluids filled to capacity.

2.2.2 MULTI-FUEL VEHICLE—A vehicle, such as a dual- or bi-fuel vehicle, equipped to operate on more than one type of fuel, e.g., either compressed natural gas or gasoline.

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2.2.3 VARIABLE FUEL VEHICLE—A vehicle equipped to operate on a variety of fuel blends, e.g., a mixture of gasoline and methanol.

2.2.4 RATED ENGINE SPEED—The engine speed at which the engine delivers rated power output as defined in SAE J1349, as determined by the manufacturer.

2.2.5 THROTTLE CONTROL—The driver operated pedal (or other control) which connects through some mechanism to the engine fuel metering device (carburetor, fuel injectors, fuel distributor, or equivalent device) and thereby controls the engine power output.

NOTE—For the purpose of this document, depression of the throttle control acts to increase engine speed and release of the throttle control acts to reduce engine speed.

3. Vehicle Operation

3.1 The test mass of the vehicle, including the driver and equipment, shall not exceed 125 kg over the curb mass (fuel level may be reduced as needed to ensure that this requirement is met).

3.2 The powertrain and exhaust system temperatures shall be within the normal operating range throughout each test run. A 1 min stabilizing period with the engine at idle speed and the transmission in neutral is required prior to each test run.

NOTE—Usually a vehicle brought to normal engine coolant temperature through moderate driving operations is adequately conditioned for testing.

3.3 Vehicle tires shall be inflated to the proper pressure in accordance with the manufacturer's recommendations.

3.4 Preliminary runs to familiarize the driver and to establish the vehicle operating conditions should be made before taking sound level measurements.

3.5 Acceleration Test—The acceleration test is the primary test mode and must be conducted first to obtain information necessary to conduct the deceleration test.

3.5.1 For this test, the vehicle shall approach the measurement area along the vehicle path with the vehicle speed stabilized at 48 km/h ± 1.2 km/h. The highest-numerical-ratio transmission gear shall be used that will result in the front of the vehicle reaching or passing the entry point of the end zone before rated engine speed is attained. It is recommended that the approach speed be held constant for a distance of at least 7.5 m prior to reaching the start point.

When the front of the vehicle reaches the start point ±1.5 m, the throttle control shall be fully depressed as rapidly as possible and the vehicle allowed to accelerate until the engine reaches rated engine speed. The test run is then terminated and the throttle control may be released.

Should rated engine speed not be attained in the end zone, the test run is nonetheless terminated when the front of the vehicle reaches the end of the end zone. The maximum engine speed attained should be noted (see 3.5.1).

3.5.2 When vehicles equipped with automatic transmissions downshift from the gear ratio determined in accordance with 3.5.1, the downshift shall be prevented by one of the following methods:

a. The approach speed of the vehicle may be increased to a maximum of 60 km/h.

b. Maintain the speed at 48 km/h, with the fuel supply to the engine limited to 95% of the supply necessary for full load.

NOTE—This condition shall be satisfied in the case of a spark-ignition engine when the angle of the butterfly valve is 90% of full travel, and in the case of a compression-ignition engine when the movement of the feed-rack of the injection pump is limited to 90% of its stroke.

c. The downshift mechanism may be disabled as recommended by the vehicle manufacturer.

3.5.3 If the vehicle is equipped with all-wheel drive that can be engaged or disengaged by operator control, the position used for normal urban driving shall be used.

3.5.4 If the vehicle is equipped with a multi-mode exhaust system that can be switched between modes by operator control, the vehicle shall be tested in each mode and the mode yielding the highest sound level shall be recorded.

3.5.5 If the vehicle is equipped with two or more driving modes (e.g., "normal" and "performance") affecting transmission shift schedules that can be engaged by operator control, the vehicle shall be tested in each mode and the mode yielding the highest sound level shall be recorded.

3.5.6 If the vehicle is equipped for operation on variable fuels or fuel mixtures, or if the vehicle is equipped for multiple (dual- or bi-) fuel operation, the vehicle shall be tested using each fuel or fuel mixture unless prior testing has established that the maximum sound level is produced when using a particular fuel or fuel mixture, in which case the vehicle shall be tested using that fuel or fuel mixture only.

3.5.7 If the vehicle is equipped with two or more multi-mode systems yielding a large number of possible combinations then a sufficient number of combinations shall be tested to establish a sound level range. Henceforth, a combination deemed to produce the highest sound levels in the sound level range shall be tested, and these data shall be recorded.

3.6 Deceleration Test—The deceleration test shall also be conducted unless prior testing has established that the maximum sound level is produced in the acceleration test mode.

3.6.1 The maximum engine speed attained in the acceleration test is to be used as the approach speed for the deceleration test (if conducted). This approach speed will be rated engine speed or the average of the terminal engine speed values at the end of the end zone as determined in 3.4.1.

3.6.2 For this test, the vehicle shall approach the measurement area along the vehicle path in the same gear used for the acceleration test with the engine speed stabilized at the speed determined according to 3.5.1. It is recommended that the approach speed be held constant for a distance of at least 7.5 m prior to reaching the start point. When the front of the vehicle reaches the start point ±1.5 m, the throttle control shall be completely released as rapidly as possible and the vehicle allowed to decelerate until the engine speed drops to one-half the approach speed or the front of the vehicle reaches the end of the end zone.

4. Measurements

4.1 The sound level meter shall be set for fast (F) exponential time-averaging and for the A-weighted network.

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

4.3 Measurements shall be made only when the wind speed does not exceed 19 km/h.

4.4 The sound level meter or indicating instrument shall be observed during the constant-speed approach and acceleration or deceleration test phases specified in 3.4 or 3.5. The highest sound level occurring during this observation period shall be recorded.

4.4.1 If an instantaneous sound level "spike" occurs at depression of the throttle control at the start of the acceleration test due to momentary loss of tire traction (tire "chirp"), the "spike" shall be disregarded.

4.5 Four measurements shall be made for each side of the vehicle unless it has been established, from prior testing, that one side has the highest sound level, in which case only the side having the highest sound level need be measured. All values shall be recorded. The sound level for either side of the vehicle shall be the arithmetic average of the two highest readings which are within 2 dB of each other. If no two measurements in the initial set of four are within 2 dB, additional measurements shall be made until two measurements are within this range.

4.6 The reported sound level shall be that for the side of the vehicle having the highest sound level, as determined according to 4.5, from either the acceleration test mode or the deceleration test mode (if conducted).

5. Instrumentation

5.1 The instrumentation necessary to conduct this test shall meet the minimum performance requirements specified as follows.

5.2 The sound level meter shall meet the Type 1 or S1A requirements of ANSI S1.4-1983 and S1.4A-1985.

5.2.1 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 providing the system is in conformance with SAE J184.

5.3 The sound level calibrator shall be accurate to ±0.5 dB (see 7.3.4).

5.4 Engine and vehicle speed shall be measured with instruments having an accuracy of ±3% at the speeds required for the measurements being made (see 7.4).

5.5 The anemometer shall be accurate to ±10% at 19 km/h wind speed.

5.6 A microphone windscreen may be used, provided that it does not affect the microphone response more than ±1 dB for frequencies from 20 to 4000 Hz and ±1.5 dB for frequencies from 4000 to 10 000 Hz.

6. Test Site

6.1 The test site shall be a flat open space free of large reflecting surfaces such as parked vehicles, signboards, buildings, or hillsides located within 30 m of the measurement area. The measurement area, which is defined as the plane surface fixed by the point at the microphone location and the end points of the end zone on the far side of the traffic lane in both directions of vehicle travel, shall be flat to within ±0.05 m. The entire plane may slope toward or away from the microphone for drainage. The vehicle path shall be of minimal grade end-to-end to avoid variations in vehicle loading. To minimize measurement variability, it is recommended that a two-sided site have both measurement areas in the same uniform plane. See 6.5 and 6.6, Figure 1, and Appendix A for flatness measurement procedure.

6.2 The surface of the measurement area shall be concrete or nonporous asphalt, dry, and free from snow, soil, or other extraneous material.

6.3 The test site shall include a vehicle path of relatively smooth concrete or asphalt, dry, and free of extraneous materials such as gravel and of sufficient length for acceleration, deceleration, and stopping of the vehicle.

6.4 The test site surface sound absorption coefficient (normal incidence), as measured in situ by the impedance tube method, shall be 0.10 or less.

6.5 The microphone shall be located 15 m from the centerline of the vehicle path and 1.2 m above the ground plane. The reference axis of the microphone shall lie in the vertical plane containing the perpendicular to the vehicle path through the microphone location.

6.6 The following fixed points and zones shall be established on the vehicle path:

6.6.1 The start point, 7.5 m ahead of the perpendicular to the vehicle path through the microphone location.

6.6.2 The end zone, starting at 7.5 m beyond, and ending at 38 m beyond the perpendicular to the vehicle path through the microphone location.

6.7 If it is desired to measure the sound level for both sides of the vehicle during each test run, another microphone location, measurement area, and clear area shall be established laterally opposite, meeting the requirements of 6.1, 6.2, and 6.5.

7. General Comments

7.1 It is recommended that persons technically trained and experienced in current sound measurement techniques select the test instrumentation and conduct the tests.

7.2 When making sound level measurements, not more than one person other than the observer reading the meter shall be within 15 m of the vehicle or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

7.3 Proper use of all test instrumentation 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. Specific items to be considered are:

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

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

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

7.3.4 Proper acoustical calibration procedures, to include the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Internal calibration is acceptable for field use, provided that external calibration is accomplished immediately before and after field use.

7.4 Many tachometers in common use have an appreciable time lag in response during vehicle acceleration. The use of such a tachometer without suitable correction could result in the attainment of higher than intended engine speed and possible effects on measured sound levels.

7.5 Vehicles used for tests shall not be operated in a manner such that the break-in procedure specified by the manufacturer is violated.

7.6 It should be recognized that variations in measured sound levels may occur due to variations in test site, ambient weather differences (temperature, wind, and their gradients), test equipment differences, and inherent differences between nominally identical vehicles.

8. Notes

8.1 Marginal Indicia—The (R) 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.

PREPARED BY THE SAE LIGHT VEHICLE EXTERIOR SOUND LEVEL STANDARDS COMMITTEE AND THE SAE VEHICLE SOUND LEVEL FORUM COMMITTEE

APPENDIX A

A.1 Procedure for determining measurement area flatness (refer to 6.1).

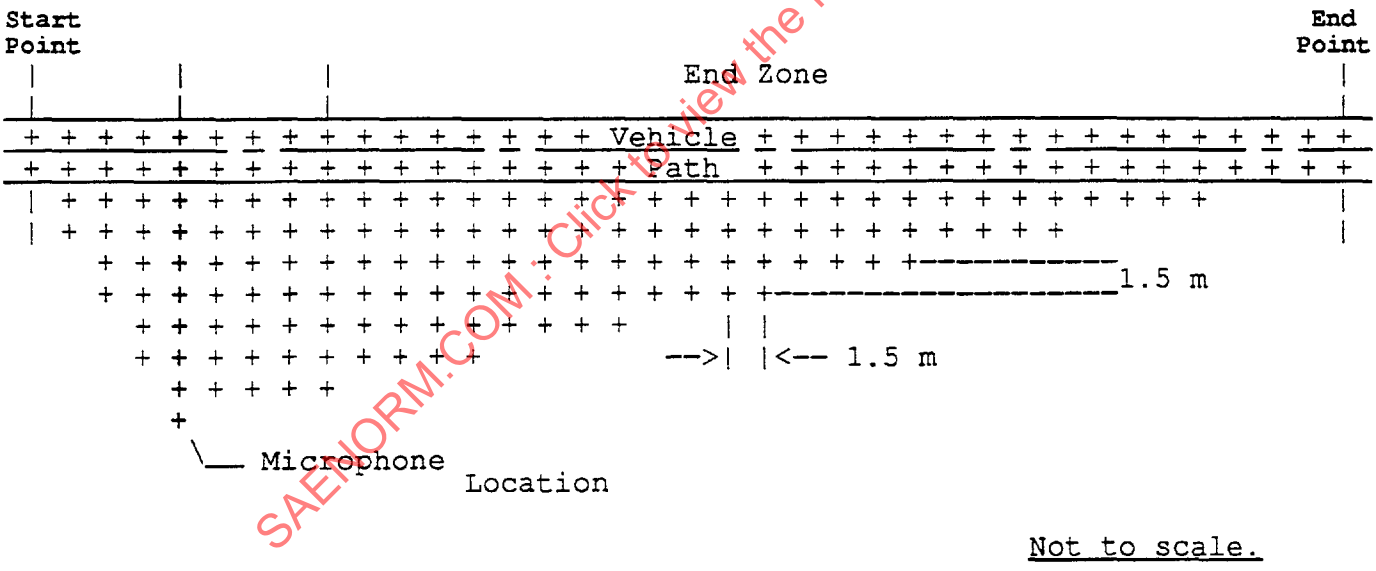
1. Establish a 1.5 m x 1.5 m square grid on the measurement area (Figure A1). If the test site is double sided, the operation may be performed either for the total plane of the combined measurement areas or separately for each of the measurement areas. (It is recommended, to minimize measurement variability, that a two-sided site have both measurement areas in the same uniform plane.)

2. Measure the relative elevation of each of the grid points using a surveying level and an elevation rod calibrated in at least 6 mm increments.

3. Analyze the relative elevation data to determine a "best fit" plane based on two-dimensional linear regression analysis.

4. Calculate the deviations, in centimeters, of the actual site elevation from the best fit plane.

5. If the difference between maximum positive and negative deviations is greater than 10 cm, then the site exceeds the ±5 cm flatness requirement.



Source: U.S. Environmental Protection Agency Noise Advisory Circular: A/C No. 3, January 27, 1978.

FIGURE A1—MEASUREMENT AREA FLATNESS TEST GRID

Rationale—This revision of this SAE document was undertaken by the Light Vehicle Exterior Sound Level Subcommittee in 1993 for the primary purpose of taking into account technical developments including, but not limited to, multi-mode exhaust systems, dual and variable fuel vehicles, and selectable operating modes. It was also deemed necessary to address advancements in transmission designs which could lead to procedural problems.

This revision will also reflect a change to a completely new numbering system (new structure per guidelines of SAE TSB 002, revised in June of 1992). This may cause minor confusion for longtime users of SAE J986, but it brings the document up to date with current SAE guidelines which in the long term should serve to minimize confusion resulting from inconsistencies in numbering logic, from document to document.

Also, where appropriate, included are editorial changes to update reference document approval dates to current revisions. These changes are not substantive, do not preclude the continued use of current instrumentation and test equipment and, therefore, are not discussed in the following explanation of differences between this revision of SAE J986 and the SAE J986 OCT88 revision.

The following discussion of significant changes appearing in this revision of SAE J986 is presented according to the affected sections of the document.

1. Scope (formerly 1.1)—The second paragraph has been revised to remove references to SAE J1030 which is being cancelled (no longer reviewed or updated). Users wishing to obtain SAE J1030 in its present form may be able to do so by contacting SAE.

2. References

2.1 Applicable Documents—This paragraph was formerly Section 7 (References).

2.2 Definitions—This paragraph was formerly 1.2 (Definitions).

2.2.1 This paragraph is added to include the definition of 'curb mass' to support addition of a requirement for mass limitations for vehicles being tested in 3.1.

2.2.2 This paragraph is new and provides a definition for multi-fuel vehicle.

2.2.3 This paragraph is new and provides a definition for variable fuel vehicle.

2.2.4 This paragraph is renumbered from 1.2.1.

2.2.5 This paragraph is renumbered from 1.2.2.

3. Vehicle Operation—This section was formerly Section 4 (Vehicle Operation).

3.1 This paragraph is added to establish criteria for the test mass of the vehicle.

3.2 This paragraph is renumbered from 4.3.

3.3 This paragraph is renumbered from 4.4.