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HIGHWAY VEHICLE STANDARD

an American National Standard

SAE J986

Issued July 1967
Revised Oct. 1988

Superseding J986 FEB87

SOUND LEVEL FOR PASSENGER CARS AND LIGHT TRUCKS

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1. INTRODUCTION:

1.1 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 (weight) rating of 4540 kg (10 000 lb) or less.

The test procedure of this standard is characterized by having fixed initial conditions (specified initial vehicle speed and gear selection at a fixed start point on the test site) in contrast to the procedure of SAE J1030 FEB87, Maximum Sound Level for Passenger Cars and Light Trucks, which has fixed terminal conditions (attainment of rated engine speed at a fixed end point on the test site). Full-throttle acceleration and closed-throttle deceleration of the vehicle are included in both procedures.

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

1.2 Definitions:

1.2.1 Rated Engine Speed: The engine speed at which the engine delivers rated power output as defined in SAE J1349 JUN85, Engine Power Test Code - Spark Ignition and Diesel, as determined by the manufacturer.

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1.2.2 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 standard, depression of the throttle control acts to increase engine speed and release of the throttle control acts to reduce engine speed.

2. INSTRUMENTATION:

2.1 The instrumentation necessary to conduct this test shall meet the minimum performance requirements specified below.

2.2 Ø The sound level meter shall meet the Type 1 or S1A requirements of the American National Standard Specification for Sound Level Meters, S1.4-1983 and S1.4A-1985.

2.2.1 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 AUG87, Qualifying a Sound Data Acquisition System.

2.3 The sound level calibrator shall be accurate to ±0.5 dB. (See paragraph 6.3.4.)

2.4 Ø Engine speed and vehicle speed shall be measured with instruments having an accuracy of ±3% at the speeds required for the measurements being made. (See paragraph 6.4.)

2.5 The anemometer shall be accurate to ±10% at 19 km/h (12 mph) wind speed.

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

3. TEST SITE:

3.1 Ø The test site shall be an open space free of large reflecting surfaces such as parked vehicles, signboards, buildings, or hillsides located within 30 m (100 ft) 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 (±2.0 in). 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 paragraphs 3.4 and 3.5, Fig. 1 and Appendix A for flatness measurement procedure.

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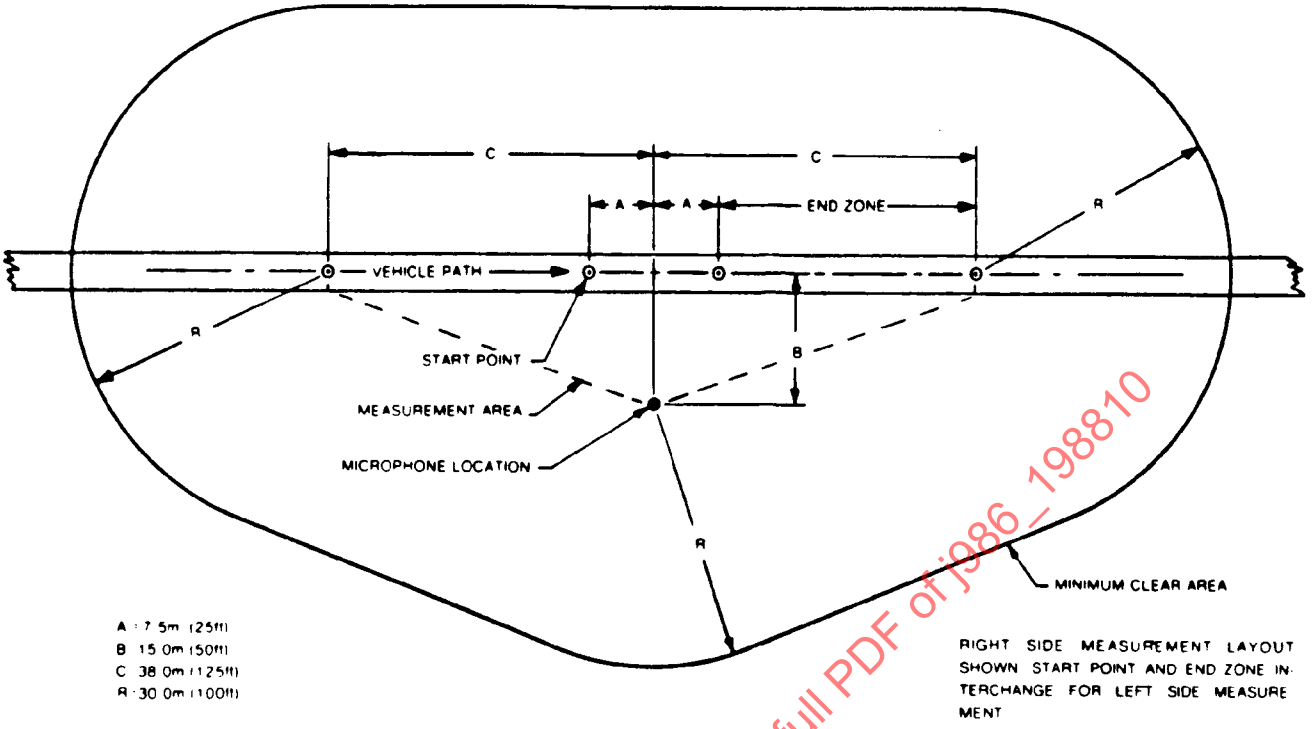

FIGURE 1 - Minimum Test Site

3.2 The surface of the measurement area shall be concrete or non-porous asphalt, dry and free from snow, soil, or other extraneous material.

3.3 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.

3.4 The microphone shall be located 15 m (50 ft) from the center line of the vehicle path and 1.2 m (4 ft) 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.

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

3.5.1 The start point, 7.5 m (25 ft) ahead of the perpendicular to the vehicle path through the microphone location.

3.5.2 The end zone, starting at 7.5 m (25 ft) beyond, and ending at 38 m (125 ft) beyond the perpendicular to the vehicle path through the microphone location.

3.6 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 paragraphs 3.1, 3.2, and 3.4.

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4. VEHICLE OPERATION:

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

4.1.1 Ø For this test, the vehicle shall approach the measurement area along the vehicle path with the vehicle speed stabilized at 48 km/h (30 mph). 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 (25 ft) prior to reaching the start point.

When the front of the vehicle reaches the start point, the throttle control shall be fully depressed as rapidly as possible and the vehicle allowed to accelerate until the engine speed 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 paragraph 4.1.4).

4.1.2 Ø When vehicles equipped with automatic transmissions downshift from the gear ratio determined in accordance with paragraph 4.1.1, the downshift shall be prevented by either of the following:

a) the downshift mechanism may be disabled as recommended by the vehicle manufacturer, or

b) the approach speed of the vehicle may be increased to a maximum of 60 km/h (37 mph).

4.1.3 Ø 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.

4.1.4 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 is rated engine speed, if attained in the acceleration test mode, or the average of the terminal engine speed values at the end of the end zone as determined in paragraph 4.1.1.

4.2 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.

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4.2.1 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 terminal speed determined in paragraph 4.1.1. It is recommended that the approach speed be held constant for a distance of at least 7.5 m (25 ft) prior to reaching the start point. When the front of the vehicle reaches the start point, 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 of the approach speed or the front of the vehicle reaches the end of the end zone.

4.3 The power train 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.

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

5. MEASUREMENTS:

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

5.2 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.

5.3 Measurements shall be made only when the wind speed is below 19 km/h (12 mph).

5.4 The sound level meter or indicating instrument shall be observed during the constant-speed approach and acceleration or deceleration test phases specified in paragraphs 4.1 or 4.2. The highest sound level occurring during this observation period shall be recorded.

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

5.5 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 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.

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5.6 The reported sound level shall be that for the side of the vehicle having the highest average sound level, from either the acceleration test mode or the deceleration test mode (if conducted).

6. GENERAL COMMENTS:

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

6.2 When making sound level measurements, not more than one person other than the observer reading the meter shall be within 15 m (50 ft) 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.

6.3 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:

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

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

6.3.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems;

6.3.4 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.

6.4 Many tachometers in common use have an apprciable 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.

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

6.6 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.

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7. REFERENCES:
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7.1 SAE J184 AUG87, Qualifying a Sound Data Acquisition System.

7.2 SAE J1030 FEB87, Maximum Sound Level for Passenger Cars and Light Trucks.

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

7.4 American National Standard Specification for Sound Level Meters, S1.4-1983 and S1.4A-1985. (Available from the American National Standards Institue, 1430 Broadway, New York, NY 10018.)

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

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.

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Ø APPENDIX A

Procedure for determining measurement area flatness (ref. paragraph 3.1).

1. Establish a 1.5 m x 1.5 m (5 ft x 5 ft) square grid on the measurement area (Figure A-1). 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 (0.24 in) 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 inches, 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 (4 in), then the site exceeds the ±5 cm (2-in) flatness requirement.

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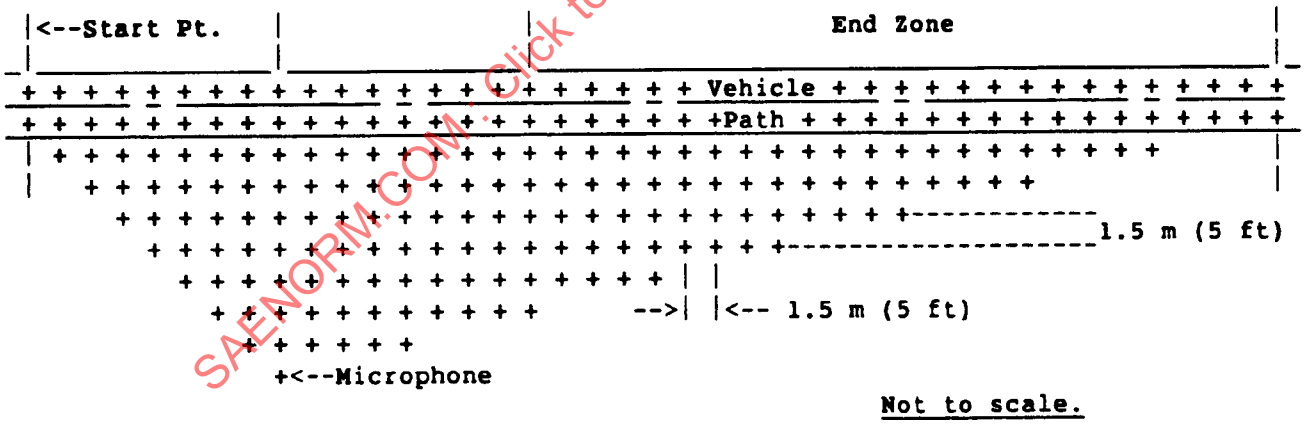

Source: U.S. Environmental Protection Agency Noise Advisory Circular: A/C No. 3, January 27, 1978.

FIGURE A-1 - Measurement Area Flatness Test Grid

RATIONALE:

This revision of this SAE Standard was undertaken by the Light Vehicle Exterior Sound Level Subcommittee in mid-1986 for the primary purpose of establishing formal requirements for vehicle operation with respect to averting a downshift to low gear during performance of the test for vehicles equipped with automatic transmissions that meet the requirements of testing in a gear other than low (1st) gear.

Additional changes are made for the purpose of standardizing requirements for a test site by establishing a detailed specification for flatness of the surface of the reflecting plane defined by the measurement area(s).

Also included are a number of editorial changes, primarily 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 J986 NOV81.

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

1.1 The third paragraph has been amended to eliminate ambiguous language which tended to emphasize the primary usefulness of this standard as being particularly applicable to high performance vehicles. The deleted language implied inappropriate limitations to the scope of this standard in contradiction to its applicability and actual usefulness.

3.1 This section has been expanded to include detailed specifications for flatness of the reflecting plane. This is a critical parameter in test site construction and, in keeping with sound engineering practices, this specification establishes uniformity in test parameters, results in more reliable test data by controlling one of the known variables affecting test results and tends to reduce site-to-site variability for improved universality of sound level ratings for vehicles tested in accordance with this standard.

4.1.1 The second paragraph is amended to more closely control end-of-test conditions for the purpose of improving repeatability, consistency and precision of test results.

The previous end-of-test requirements called for reaching rated engine speed and modulating the throttle setting to maintain constant engine speed throughout the end zone. In actual practice, dependent upon vehicle characteristics and driver reaction time, relatively inconsistent overshoot of rated engine rpm tended to occur and was likewise reflected in test results.

The revised requirements permit the throttle to be released gradually and are specifically intended to avoid conflict with the formal deceleration test procedure.

4.1.1 The last line is amended to refer to paragraph 4.1.4, renumbered from 4.1.3 due to other changes in this revision.

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RATIONALE (Continued):

4.1.2 This section is revised primarily to offer the alternative of increasing vehicle speed by up to 12 km/h to prevent a downshift to low gear for vehicles that meet the requirements for testing in an intermediate gear.

The matter of disconnecting the downshift mechanism may not be a desirable alternative for preventing an automatic downshift to low gear. Such action may have the potential for damage to automatic transmissions. Likewise, disabling the downshift shall be done in a manner that is compatible with equipment design and it is recommended that expert advice be sought before undertaking such measures.

It is recognized that increasing the approach speed will result in a commensurate increase in the end-of-test engine speed and may result in an overall higher sound level. Therefore, this alternative can be considered to be a conservative approach to determination of vehicle sound level. However, it may be acceptable for vehicles with an adequate design margin for applicable sound level limits for the test.

4.1.3 This section is all new and has been adopted for the express purpose of establishing operational criteria for all wheel drive vehicles for sound level testing, based on the predominant mode of vehicle operation in normal use. This requirement is not intended to preclude the use of this standard for optional testing of all wheel drive vehicles in the alternate operational mode.

4.1.4 This section is renumbered from 4.1.3.

5.4.1 This section is all new and has been incorporated to avoid inconsequential interference with performance of the sound level test. The basis for this added section is that the primary focus of this standard is performance of a low speed, wide open throttle sound level test to determine the noise signature of a moving vehicle due to power train and directly related sources. The initial conditions include a 48 km/h (30 mph) approach speed specifically to minimize the influence of tire/road surface interface noise effects.

Tire "chirp", an instantaneous burst of acoustical energy due to a momentary loss of traction occurring at initiation of wide open throttle, is not to be included as "data" for this test and, should it occur, the resulting noise spike is to be disregarded in reported test results.

It is recognized that certain types of test equipment, such as peak hold sound level meters, may require a "reset" or analogous measure to effectively initiate data-taking after the occurrence of the noise spike to yield correct results for the test.

6.6.1 This section is deleted due to inclusion of the test site flatness requirements in Section 3.1 and provision of a detailed procedure for determining test site flatness in Appendix A.

Appendix A This appendix has been added for purposes of establishing definitive criteria to determine the flatness of the reflecting plane in support of section 3.1 of the standard. These criteria are included as an appendix with the express intent of making them an integral and inseparable part of the standard.

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