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SURFACE VEHICLE STANDARD

SAE J1470

REV.
MAR92

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Submitted for recognition as an American National Standard

(R) MEASUREMENT OF NOISE EMITTED BY ACCELERATING HIGHWAY VEHICLES

1. Scope and Field of Application—This SAE Standard is equivalent to ISO Standard 362-1981 except for the differences detailed in Appendix A, and includes the modifications adopted by WP29 in ECE R51.

This document specifies an engineering method for measuring the noise emitted by accelerating highway vehicles of all types (except motorcycles) in intermediate gears with full utilization of the available engine power.

The method is designed to meet the requirements of simplicity and reproducibility of results under realistic vehicle operating conditions.

Measurements relate to operating conditions of the vehicle which give the highest noise level consistent with urban driving and which lead to reproducible noise emissions. Therefore, an acceleration test at full throttle from a stated engine or vehicle speed is specified.

The test method calls for an acoustical environment which can only be obtained in an extensive open space.

If measurements have to be carried out on the road in an acoustical environment which do not fulfill the requirements stated in this document, it should be recognized that the results obtained may deviate appreciably from the results obtained using the specified conditions.

The results obtained by this method give an objective measure of the noise emitted under prescribed conditions of test. However, it is necessary to consider the fact that the subjective appraisal of the annoyance of different classes of motor vehicles is not simply related to the indications of a sound level meter.

2. References and Related Documents

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—Spark Ignition and Diesel

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

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

ANSI S1.40-1984—Specification for Acoustical Calibrators

2.1.3 ECE PUBLICATIONS—Available from United Nations Economic Commission for Europe, Palais Des Nations, CH-1211, Geneva 10, Switzerland.

ECE R51—Uniform Provisions Concerning the Approval of Motor Vehicles Having at Least Four Wheels with Regard to Their Noise Emission

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- 2.1.3 IEC PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.
IEC Publication 651—Sound Level Meters
- 2.1.4 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.
ISO 362-1981—Acoustics—Measurement of noise emitted by accelerating road vehicles—
Engineering method
ISO 1585-1982—Road vehicles—Engine test code—Net power
ISO 3833-1977—Road vehicles—Types—Terms and definitions
ISO 1176-1974—Road vehicles—Weights—Vocabulary

2.2 Definitions—For the purpose of this document, the following definitions apply.

- 2.2.1 AUTOMATIC DOWNSHIFT—A gear change to a lower gear (higher numerical ratio) which occurs outside the control of the driver.
- 2.2.2 FORCED DOWNSHIFT—A gear change to a lower gear (higher numerical ratio) which can be initiated at the will of the driver. A forced downshift may be initiated, for example, by a change in the position of the throttle pedal, thereby activating an external switch which affects the downshift.
- 2.2.3 KICKDOWN—A forced downshift to the lowest possible gear (first or low gear).

3. Instrumentation

3.1 Instrumentation for Acoustical Measurements—The sound level meter shall meet Type 1 or Type S1A requirements of ANSI S1.4-1983.

The sound level meter shall be set for the frequency weighting "A" and the time weighting "F."

The calibration of the sound level meter shall be checked and adjusted according to the manufacturer's instructions using a *sound level meter calibrator meeting the requirements of ANSI S1.40-1984* (for example, a pistonphone) at the beginning of the measurements and rechecked and recorded at the end of them. (See 6.3.4)

If the readings of the sound level meter obtained from these calibrations change by more than 1 dB during a series of measurements, the test shall be considered invalid.

Compliance of the sound level meter with ANSI S1.4-1983, Type 1, shall be verified at intervals of not more than 2 years.

A microphone windscreen may be used, provided that it does not affect the microphone response by more than ± 1 dB for frequencies from 20 to 4000 Hz and ± 1.5 dB for frequencies from 4000 to 10000 Hz.

As an alternative to making direct sound level measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder, or other indicating instrument providing the system is in conformance with SAE J184.

3.2 Instrumentation for Speed Measurements—Engine speed and vehicle speed shall be measured during the approach with instruments having an accuracy of 3% or better at the speeds required for the measurements being performed.

3.3 Other Instrumentation—Wind speed shall be measured with an anemometer that is accurate to $\pm 10\%$ at 18 km/h.

4. Acoustical Environment, Meteorological Conditions, and Background Noise

4.1 Test Site—The test site shall be such that hemispherical divergence exists between the noise source and the microphone to within ± 1 dB.

This condition is deemed to be satisfied if the following requirements are met:

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- a. Within a radius of 50 m around the center of the track, the space shall be free of large reflecting objects such as fences, rocks, bridges, or buildings. (See Figure 1.)

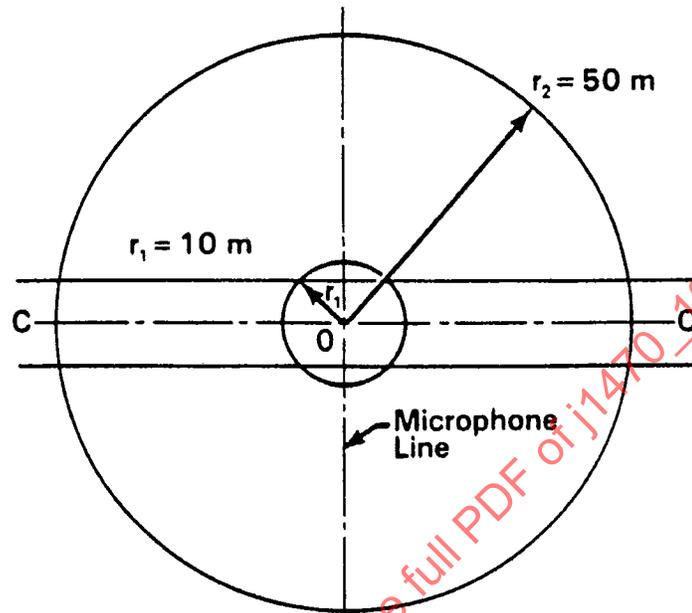


FIGURE 1—TEST SITE

- b. The entire test track and the surface of the site up to 10 m from the center "O" of the track shall consist of concrete, non-porous or sealed asphalt, or similar hard material and be free of absorbing materials such as powdery snow, long grass, or ashes. (See Figure 1.)
- c. In the vicinity of the microphone, there shall be no obstacle that could influence the acoustical field and no person shall be between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading.

A primary concern regarding the test site is flatness of the measurement area. It is recommended that the measurement area be flat within ± 0.05 m, particularly in that portion of this area between the vehicle path centerline and the microphone location and to a distance of 15 m before and after the intersection of the vehicle path and the perpendicular to it passing through the microphone location. (See Figure 2.)

4.2 Meteorological Conditions—The measurements shall not be made in adverse weather conditions. It is recommended that tests should not be carried out if the wind speed at microphone height exceeds 5 m/s (18 km/h).

4.3 Background Noise—The background noise (including any wind noise) shall be at least 10 dB below that produced by the vehicle under test.

5. Test Procedure

5.1 Microphone Positions—The distance from the microphone positions to the reference line CC (see Figure 2) on the test track shall be 7.5 m.

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

5.5 Operating Conditions

5.5.1 GENERAL CONDITIONS—The vehicle shall approach line AA with the path of its centerline following as closely as possible line CC as specified in 5.5.2.1 to 5.5.2.3 as appropriate.

When the front of the vehicle reaches line AA, the throttle shall, as rapidly as possible, be opened as fully as will ensure maximum acceleration without operating kickdown (if any), and held until the rear of the vehicle reaches line BB; the throttle shall then be closed as rapidly as possible.

Any trailer which is not readily separable from the towing vehicles shall be ignored when considering the crossing of line BB.

If the vehicle is fitted with more than two-wheel drive, it shall be tested in the drive which is intended for normal road use.

If the vehicle incorporates equipment which is not normally in operation on the road, such as a concrete mixer, a compressor, etc., this equipment shall not be in operation during the test.

NOTE—It is recommended that supplementary measurements be made with the equipment operating.

5.5.2 SPECIAL CONDITIONS

5.5.2.1 *Vehicles Without Transmission*—The vehicle shall approach line AA at a uniform vehicle speed corresponding to one of the following:

- a. An engine rotational speed equal to 3/4 of the speed, n , which is the rated engine speed, or
- b. 3/4 of the engine maximum rotational speed allowed by the governor at full load conditions of the engine, or
- c. 50 km/h, whichever is the lowest.

5.5.2.2 *Manual Transmission Vehicle*

a. Approach Speed—The vehicle shall approach line AA at a uniform vehicle speed corresponding to one of the following:

- (1) An engine rotational speed equal to 3/4 of the speed, n , which is the rated engine speed, or
- (2) 3/4 of the engine maximum rotational speed allowed by the governor at full load conditions of the engine, or
- (3) 50 km/h, whichever is the lowest.

b. Choice of the Gear Ratio

Vehicles having a manufacturer's gross vehicle mass rating of not more than 4540 kg, and vehicles fitted with a manual transmission having four or fewer forward gears, shall be tested in second gear. Vehicles fitted with a transmission having more than four forward gears shall be tested in both second and third gears. The average value of the sound levels recorded for these two conditions shall be calculated. This average is the reported sound level.

Vehicles having a manufacturer's gross vehicle mass rating of not more than 4540 kg, and vehicles fitted with a transmission having more than four forward gears and equipped with engines having a maximum power higher than 140 kW and power max-design mass ratio higher than 75 kW/t, shall be tested only in third gear provided that the speed at which the rear of the vehicle passes line BB in third gear exceeds 61 km/h.

Vehicles having a manufacturer's gross vehicle mass rating of more than 4540 kg and buses whose total number of forward gears is N (including those obtained by means of an auxiliary transmission or multi-gear axle) shall be tested successively with the gear selection equal to or higher than $N/2$. Only the condition giving the highest sound pressure level shall be reported.

5.5.2.3 *Automatic Transmission Vehicle*—Three cases may occur:

- a. Vehicles without a manual selector shall be tested at various uniform approach speeds of 30, 40, and 50 km/h or at 3/4 of the on-road maximum speed if this value is lower. The condition with the highest sound pressure level shall be reported.

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- b. Vehicles equipped with a manual selector shall have the test performed in the selector position used for normal urban driving. The approach speed shall be determined by one of the following:
- (1) An engine rotational speed equal to 3/4 of the speed, n , which is the rated engine speed, or
 - (2) 3/4 of the engine maximum rotational speed allowed by the governor at full load conditions of the engine, or
 - (3) 50 km/h, whichever is the lowest.

A forced or automatic downshift may occur during the test, though kickdown to the first ratio for transmissions having more than two discrete ratios shall be prohibited.

However, if during the test, in the case of vehicles having more than two separate gears, there is a downshift to first gear, this downshift may be avoided, at the manufacturer's choice, either by

- (4) Increasing the speed of the vehicle to a maximum of 60 km/h; or by
 - (5) Maintaining the speed at 50 km/h, with the fuel supply to the engine limited to 95% of the supply necessary for full load.¹
- c. If the vehicle is fitted with an auxiliary manual transmission or a multi-gear axle, the position used for normal urban driving shall be used.

In all cases, the special selector's positions for slow movements, parking, or braking shall be excluded.

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 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 using a sound level meter calibrator meeting the requirements of ANSI S1.40-1984 is accomplished immediately before and after field use.

¹ 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.

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- 6.4 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.
- 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.
- 6.7 Vehicles with diesel engines should be tested using Number 1D or Number 2D diesel fuel possessing a cetane rating from 42 to 50 inclusive.
- 6.8 Vehicles with gasoline engines shall use the grade of gasoline recommended by the manufacturer for use by the purchaser.

7. Test Report

- 7.1 In the event preparation of a formal test report is required, the report shall contain the following information:
- 7.1.1 Reference to this SAE Standard
- 7.1.2 Details of the test site, the testing ground conditions, weather conditions, date, and test personnel
- 7.1.3 The measurement equipment (including windscreen, if used)
- 7.1.4 The A-weighted sound pressure level of the background noise
- 7.1.5 The identification of the vehicle, its engine, and its transmission system
- 7.1.6 The transmission gears during the test
- 7.1.7 The road and engine speeds at the beginning of the period of acceleration
- 7.1.8 The auxiliary equipment, where appropriate, and its operating conditions and
- 7.1.9 The number of measurements and the sound pressure levels recorded, in decibels

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

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APPENDIX A

A.1 Rationale—This revision upgrades SAE J1470 from a Recommended Practice to a Standard and includes addition of ANSI S1.40 to the list of reference documents in Section 2 and 3.1, and editorial changes in 5.5.2.3b(3) and b(4) to correct an ambiguity in the original language specifying allowed downshift provisions for operation of automatic transmissions in the test. The editorial changes are in keeping with the historical intent of the original language to prohibit an automatic downshift (kick-down) to low gear during the test.

Other elements of the original rationale statement describing differences between this document and ISO 362-1981 and including provisions adopted by WP29 in ECE R51, remain unchanged. Accordingly, the description of major differences between this document and ISO 362-1981 contained in the original rationale statement is included in this appendix.

A.2 Differences

A.2.1 Section 2—The list of references includes European and U.S. documents that detail measurement equipment specifications, terminology, and measurement methodology applicable to vehicle noise testing.

When this test method is to be used for export vehicle testing, users should be aware of differences between sound level meter standards and engine power rating methods.

A.2.2 Section 2.2.3—This section has been added to establish a difference between a forced downshift from third gear to second gear, which is permissible, and a forced downshift to low or first gear, here-in defined as kickdown, which is specifically disallowed during test vehicle operation.

A.2.3 Section 3.1—Paragraph 1 of this section incorporates identification of the U.S. standard for sound level meters. It is substantially equivalent to IEC Publication 651.

A.2.4 Section 3.1—This section is changed to include windscreen performance specifications. The ISO procedure requires the microphone manufacturer to verify performance of the windscreen. This procedure establishes quantitative values for acceptability.

A.2.5 Section 3.1—This section is also changed to add provisions for the use of recording or other equipment as alternatives to a Type 1 sound level meter as long as such equipment meets the Type 1 specifications according to SAE J184a.

A.2.6 Section 4.1—Paragraph 1 of this section has been changed to incorporate specific criteria in place of the terms "substantially level" used in the ISO procedure. Test experience with other SAE procedures supports the need for such definition.

A.2.7 Section 4.2—Reference to "gusts of wind" is deleted because the steady wind limits and background noise specification are adequate to provide minimum requirements for good measurement practices.

A.2.8 Section 5.4—This section is changed to require that other temperature-sensitive, noise-related equipment, in addition to the engine, also be brought to normal operating temperature prior to the start of testing.

A.2.9 Section 5.5.2.2b—The mass breakpoint is changed to incorporate the U.S. vehicle categories in accordance with federal regulations for medium and heavy trucks. European countries have somewhat different categories that affect regulated levels.

This section has also been expanded to include specific test requirements for certain high performance vehicles in accordance with changes to ECE R51 as adopted by WP29 in 1983 that are not a part of ISO 362-1981.