Operator Sound Level Measurement Procedure for Powered Mobile Construction Machinery—Singular Type Test—SAE J919b

SAE Recommended Practice
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OPERATOR SOUND LEVEL MEASUREMENT PROCEDURE FOR POWERED MOBILE CONSTRUCTION MACHINERY—SINGULAR TYPE TEST—SAE J919b

SAE Recommended Practice

Report of Construction and Industrial Machinery Technical Committee approved May 1966 and last revised by Off-Road Sound Level Committee March 1976. Rationale statement available.

1. Scope—This SAE Recommended Practice sets forth the instrumentation and procedures to be used in measuring sound levels at the operator station for powered mobile construction machinery of 15 kW (20 bhp) rated and over. This Recommended Practice is to cover machinery that has operator stations where the operator can either stand or sit and will be transported by the machine during its operation. The sound levels obtained by using the test procedures set forth in this SAE Recommended Practice are in general repeatable and are representative of the higher range of the sound levels generated by the machinery under field operating conditions, but do not necessarily represent the equivalent sound level over a field use cycle.

2. Instrumentation

2.1 A sound level meter which meets the Type 1 requirements of the American National Standard Specification for Sound Level Meters, S1.4-1971.

2.2 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 graphic level recorder or indicating instrument, providing the system meets the intended accuracy of SAE Recommended Practice J184—Qualifying a Sound Data Acquisition System—for the frequency range that is of primary concern. The inaccuracies in the magnetic tape recorder frequency response, especially at lower frequencies, must not affect the overall reading by more than ±0.5 dB(A).

2.3 An acoustical calibrator (recommended accuracy within ±0.5 dB—see paragraph 4.2.3).

2.4 A microphone windscreen may be needed under certain operating conditions. Consideration should be given to the use of a windscreen when the wind velocity across the microphone is greater than 3.6 km/h (2.2 mph) (see paragraph 4.3). A windscreen may be used as long as it does not affect the overall reading by more than ±0.5 dB(A) for the sound source that is being measured.

2.5 An anemometer or other device for measurement of ambient wind speed and direction if the machine to be tested has no operator enclosure or will be operated in open configuration—doors and/or windows open during machine operation. The recommended accuracy is ±10% at the highest wind speed encountered (see paragraph 4.2.2).

2.6 A power source rpm indicator (recommended accuracy within ±2%).

2.7 A thermometer for measurement of ambient temperature (recommended accuracy within ±1 deg).

2.8 A barometer for measuring atmospheric pressure (recommended accuracy within ±1%).

3. Procedure

3.1 Test Site

3.1.1 The test area shall consist of a smooth, uniform plane that has open space free of uncompacted snow, tall grass, and large reflecting surfaces such as a signboard, building or vertical earth and rock embankment within 15 m (49 ft) of the machine being measured (see paragraph 4.2.4).

3.1.2 Steel wheel or drum and crawler machines should be tested with the machines on a level surface of compacted earth or gravel. The moisture content should be low enough to prevent the material from sticking to the wheels, drums or tracks. Other types of machinery may be tested with the machinery on a level surface of either hardpacked earth, gravel, concrete, or asphalt. The level surface should not have over ±1% grade in the direction of travel and no more than 3% grade at right angles to the direction of travel (reference SAE J166).

3.2 Environment, Operator, and Machine Guidelines

3.2.1 No person other than the operator shall be in the operator station area of a machine.

3.2.2 The ambient sound level (including wind effects) due to sources other than machinery being measured shall be at least 10 dB(A) lower than the level of the machine being tested at the microphone location for the sound level measurements.

3.2.3 The environmental conditions such as humidity, temperature, vibration, stray electromagnetic fields, etc., shall be within the limits specified by the manufacturer of the test instrumentation.

3.2.4 An operator shall be selected whose physical dimensions are as close as possible to a 50th percentile person (reference SAE J833a):

(a) standing height—bare feet—	160 cm (62.9 in) to 173.5 cm (68.3 in)
(b) ear height—sitting—	72.1 cm (28.4 in) to 77.5 cm (30.5 in)
(c) head width—	12.9 cm (5.1 in) to 13.5 cm (5.3 in)

An operator with physical dimensions that fall outside the 5th percentile to the 95th percentile range (ear height—sitting 66.9 cm [26.2 in]-82 cm [32.3 in]) should not be permitted to operate the machinery during this sound evaluation test.

3.2.5 The microphone shall be located within a range of 8-16 cm (3-6 in) to the right of the operator's right ear. It shall be in line with the ear and orientated with respect to the predominant sound source so that the sound pressure waves strike the diaphragm at the angle for which the microphone was calibrated to have the flattest response characteristic over the frequency range of interest. The recommended microphone is one that has a diameter of 1.3 cm (½ in).

3.2.6 When the test machine has a fully enclosed operator station, measurements are to be taken with windows, doors, and vents in a fully closed position and the appropriate climatizing accessories turned on to maximum fan speed. The test machine shall also be tested under a fully open configuration—all doors, windows and vents open if they are designed to be open during machinery operation. Climatizing accessory fans shall be off for the latter test.

3.2.7 The machine shall be at a stabilized operating temperature during the test and must be operated in a manner such that the break-in procedure specified by the manufacturer is not violated.

3.3 Machine Operating Conditions

(a) For mobile construction machinery that is used primarily in a stationary mode, test per paragraphs 3.3.1.1, 3.3.1.2, and also 3.3.1.3 if applicable.

(b) For self-propelled earthmoving and construction machinery that is used primarily in a mobile mode, test per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3 and 3.3.2. For machines which have an auxiliary power source, such as on certain types of mobile cranes or excavators, the main engine and auxiliary engine shall be run separately during tests 3.3.1.1 and 3.3.1.2 with the other engine shut down. During test 3.3.1.3 only the auxiliary engine shall be run, and only the main propulsion engine run during the test prescribed in 3.3.2. For combined construction machinery (such as a loader with backhoe) test per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3 and 3.3.2.

3.3.1 Stationary Tests with Ground Propulsion Transmission Shift Selector in Neutral Position

3.3.1.1 Operate mobile construction machinery engines at no load and at a stabilized maximum governed speed (high idle). All major component drive systems should be in neutral position.

3.3.1.2 Prior to this sequence of tests decrease engine speed to low idle for a minimum of 5 min to ensure "cool" combustion chamber surfaces temperatures. Operate mobile construction machinery engines at no load with all major component drive systems in neutral position through the cycle "low idle-maximum governed speed (high idle)-low idle" as rapidly as possible, but allowing the engine to stabilize for at least 10 s at the maximum governed speed (high idle) before it is permitted to return to low idle.

3.3.1.3 With the engine at the maximum governed speed (high idle) or manufacturer's recommended engine operating speed at no load in a stabilized condition, activate the appropriate hydraulic circuits, mechanical, electrical, hydrostatic, or torque converter drive systems to cycle the major components or component from the most retracted and/or lowered position to fully extended and/or maximum height position and then back to original position. This cycling should be done as fast as practical, taking into consideration all the pertinent safety factors, and be accomplished without blowing relief valves. For short cycle hydraulic operation, the system may be "feathered." For safety reasons and undesirability of change of location of major noise source in relation to other major components of the machine, a major portion of the mobile machine, such as the tractor of a scraper unit, drum of a compactor, or the upper rotational structure of an excavator shall not be moved, or drum of a compactor placed in a vibratory mode of operation, or scraper elevator placed in operation during this stationary machine test.

3.3.2 Constant Speed Moving Test—Construction machinery shall be operated in a forward intermediate gear ratio at no load. The power source shall be operated at maximum governed speed (high idle). Intermediate is intended to mean second gear ratio for machines with three or four gear ratios, third gear ratio for machinery with five or six gear ratios, fourth gear ratio for machinery with seven or eight gear ratios, etc. (Gear ratio refers to overall gear reductions.) If there is a problem with the transmission shifting up or down in this phase of the test, one gear lower or higher may be used to eliminate the problem. Hydrostatic, electric drive or other type drive machinery will be

operated at approximately one-half its maximum ground speed with the governor control set in maximum (high idle) position at no load. If this operating condition cannot be attained because of the interaction of the engine and drive controls, then the ground speed may be increased or decreased so as to still permit the engine governor control to be set in maximum (high idle) position. Machinery that has major noise-generating components which are normally used at the above ground speed shall have these major components in operation during this moving test.

3.3.3 Construction machinery that has a major attachment that is normally used for the main operating function shall be equipped with this attachment. Examples of this are buckets on loaders and dozers on either wheel or crawler tractors. For all tests, except the component cycling, these attachments shall be in a minimum transport position of 16 cm (6 in) to 32 cm (12 in) for dozers, scrapers, etc., and for loaders use the approximate carry position as described by SAE Standard J732c—Specifications Definitions—Front End Loader.

3.4 Measurements

3.4.1 The microphone shall be located to the right of the operator's right ear as stated in paragraph 3.2.5 for all operating conditions.

3.4.2 The final resulting data shall be presented as A-weighted data with slow dynamic characteristic (slow response).

3.4.3 The ambient temperature, atmospheric pressure, and A-weighted sound level shall be measured and recorded at the operator station with the machine shut down. If the vehicle has a fully enclosed operator station, these measurements shall be taken in the same enclosure configuration as tests are run. The ambient wind speed and direction shall be measured for all tests except those which only have a close configuration—doors and or windows not designed to be open during machinery operation.

3.4.4 The stabilized maximum governed engine speed (high idle) at no load shall be measured and recorded.

3.4.5 The gear ratio and approximate ground speed used during the moving test shall be recorded.

3.4.6 The sound level meter needle movement, digital readout or graphic level recorded trace shall be observed during each test sequence at the specified microphone location. The highest value observed for all tests disregarding sounds of short duration that are out of character with the test on the machine (example: impact sound such as bucket rack against stops) shall be recorded for each test sequence. For a digital type readout the meter must be frequently reset so that the out-of-character sound levels for the test sequence are not included even if the max hold mode is being used. For the stabilized test condition, of maximum governed speed (high idle) a single reading shall be recorded. For engine cycling, constant speed moving, and component cycling test conditions (3.3.1.2, 3.3.1.3, and 3.3.2) a minimum of three valid readings shall be taken for each measuring point. (In practice this is envisioned as conducting three cycling tests and one long constant speed moving test with three separate readings spaced by a short time interval.) If for each specific test made none of the readings are within 2 dB of each other, then additional readings shall be taken until there are two that are within 2 dB of each other. The reported value shall be the average of those two values that are within 2 dB of each other. If there are two pairs of readings that are within 2 dB of each other, report the average of the higher pair. The final report shall include a sound level reading for each of the four test modes and cab configuration(s) in the format as shown in Appendix A.

4. General Comments

4.1 It is recommended that persons technically trained and experienced in the current techniques of sound measurements select the instrumentation and conduct the tests. Dedicated attention to detail and a thorough understanding of the machine and test instrumentation operational requirements shall be prerequisite of all personnel attached to the evaluation program.

4.2 Proper usage 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.

4.2.1 The effects of ambient weather conditions on the performance of all instruments (for example: temperature, humidity, and barometric pressure) should be known. Instrumentation can be influenced by low temperature, or significant changes in temperature, and caution should be exercised.

4.2.2 It is recommended that the relative wind velocity of the air mass over the microphone not exceed 20 km/h (12 mph). Extreme caution should be used in making measurements with higher relative velocities. Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems should be known.

4.2.3 Proper acoustical calibration procedure, to include the influence of extension cables, etc. should be performed. Field acoustical calibration shall be made immediately before and after each test sequence of a piece of construction machinery.

4.2.4 The overall effect due to an alternate test environment on the sound level measurement shall not exceed ±1.0 dB(A) from the sound level measurement made at the test site described in paragraph 3.1.1.

4.3 The consideration of a microphone windscreen may be deleted if an analysis of similar spectral data indicates that wind noise on the microphone has less than ±0.5 dB(A) effect on the overall value.

5. Reference Material:

ANSI S1.1-1960 (R1971), Acoustical Terminology

ANSI S1.2-1962 (R1971), Physical Measurement of Sound

ANSI S1.4-1971, Specifications for Sound Level Meters

ANSI S1.13-1971, Methods for the Measurement of Sound Pressure Levels

SAE Recommended Practice J184—Qualifying a Sound Data Acquisition System

SAE Standard J732c—Specification Definitions—Front End Loader

SAE Standard J833a—USA Male and Female Physical Dimensions for Construction and Industrial Equipment Design

SAE Recommended Practice J1057a—Identification Terminology of Earthmoving Machines

SAE Recommended Practice J166—Minimum Performance Criteria for Brake Systems for Off-Highway Trucks and Wagons

Rationale statement is on File at SAE Headquarters and is available upon request.

Applications for copies of the ANSI and ISO documents should be addressed to:

American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018

APPENDIX A

SAE J919b
CONSTRUCTION MACHINERY OPERATOR
SOUND LEVEL TEST REPORT

Type of Machinery _____ Model _____

S/N _____

	Operator Station Closed	— Open	
Stationary	_____	_____ dB(A)	Max Engine Gov. RPM _____
Idle-Max-Idle	_____	_____ dB(A)	Comp. _____
Comp. Cycling	_____	_____ dB(A)	Gear Ratio _____
Moving	_____	_____ dB(A)	Gnd. Speed _____

Test Site _____

Mic. Orientation _____

Instruments: Sound Level Meter, Recorder, Calibrator & Microphone

Type _____ Model _____ Serial No. _____

Type _____ Model _____ Serial No. _____

Type _____ Model _____ Serial No. _____

Type _____ Model _____ Serial No. _____

Other comments: _____

_____

_____

Data Author _____ Date _____