Operator Sound Level Measurement Procedure for Earthmoving Machinery—Singular Type Test—SAE J919c

SAE Standard
Completely Revised April 1979

S.A.E. LIBRARY

SAENORM.COM : Click to view the full PDF of j919c_197904

THIS IS A PREPRINT WHICH IS SUBJECT TO REVISIONS AND CORRECTIONS. THE FINAL VERSION WILL APPEAR IN THE 1980 EDITION OF THE SAE HANDBOOK.

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

LAND SEA AIR SPACE

PREPRINT

OPERATOR SOUND LEVEL MEASUREMENT φPROCEDURE FOR EARTHMOVING MACHINERY—SINGULAR TYPE TEST—SAE J919c

SAE Standard

Report of Construction and Industrial Machinery Technical Committee approved May 1966 and completely revised by Construction, Agricultural, and Off-Road Sound Level Technical Committee April 1979. Rationale statement available.

1. Purpose and Scope

1.1 Purpose—This SAE Standard sets forth the instrumentation and procedures to be used in measuring sound levels at the operator station for earthmoving machinery, as defined under SAE J1057a.

1.2 Scope—This SAE Standard is applicable to machinery of 15 kw (20 bhp) rated and over, that have operator stations where the operator can either stand or sit and will be transported by the machine during its operation. It is not intended for use with agricultural equipment. The sound levels obtained by using the test procedures set forth in this SAE Standard 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. For measurement and calculation of the operator's sound exposure, use SAE Recommended Practice J1166a.

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 requirements of SAE Recommended Practice J184a, Qualifying a Sound Data Acquisition System, for the frequency range that is of primary concern. The deviations in the magnetic tape recorder frequency response from *flat* response, especially at lower frequencies, must not affect the overall reading by more than ±0.5 dB(A).

2.3 An acoustical calibrator (accuracy within ±0.5 dB—see paragraph 4.2.4).

2.4 The use of a windscreen may be required under some test conditions (refer to paragraph 3.2.2), otherwise its use is optional, providing that it does not affect the A-weighted sound level of the source being measured by more than ±0.5 dB(A) under zero wind speed conditions. (Also refer to paragraph 4.2.2.)

2.5 An anomometer 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 accuracy is ±10% at the highest recommended wind speed. (See paragraph 4.2.2.)

2.6 A power source speed indicator (accuracy within ±2% of the indicated reading).

2.7 A thermometer for measurement of ambient temperature, (accuracy within ±1°C (1.8°F)).

2.8 A barometer for measuring atmospheric pressure (accuracy within ±1.1 kPa (0.3 in Hg) of the indicated reading).

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 (49.2 ft) of the machine being measured (see paragraph 4.2.5).

3.1.2 Steel wheel 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 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 J1152).

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.

3.2.3 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 - 1600—1735 mm (62.9—68.3 in).
(b) Ear height - sitting - 721—775 mm (28.4—30.5 in).
(c) Head width - 129—135 mm (5.1—5.3 in).

An operator with physical dimensions that fall outside the 5th percentile to the 95th percentile range (ear height - sitting - 665—818 mm (26.2—32.2 in) should not be permitted to operate the machinery during this sound evaluation test.

3.2.4 The microphone shall be located 80—160 mm (3.1—6.3 in) to the right of the operator's right ear unless the engine of the machinery is located on the left side of the operator. For machinery with the engine on the left side of the operator, the microphone shall be located 80—160 mm (3.1—6.3 in) to the left of the left ear. The face of the microphone should be in line with the ear canal. The microphone should either point in the direction of the operator's vision (head mounted) or upwards (shoulder mounted). It is invisioned that for a head mounted or a shoulder mounted microphone, the microphone will be remote mounted via a cable. Microphones mounted on the machinery should point in the forward travel direction.

Note: A 13 mm (0.5 in) nominal diameter microphone is recommended.

3.2.5 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 climitizing 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.

3.2.6 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 Tests Required

Self-propelled earthmoving machinery that is used primarily in a mobile mode shall be tested per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3, 3.3.1.4, and 3.3.2.

Combined earthmoving machinery (such as a small loader with a backhoe) shall be tested per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3, 3.3.1.4, and 3.3.2 when in the loader mode and tested per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3, and 3.3.1.4, when in the backhoe mode.

Rubber tired and track excavators shall be tested in a stationary test mode only per paragraphs 3.3.1.1, 3.3.1.2, 3.3.1.3, and 3.3.1.4.

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

3.3.1.1 Operate mobile earthmoving 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 Operate all mobile earthmoving machinery engines at no load and rated speed with all major component drive systems in neutral position. Rated speed is defined per SAE J245 or J270.

3.3.1.3 It is recommended that care be taken to ensure stabilized combustion chamber surface temperatures prior to this test sequence. For on some types of engines, such as engines with pre-combustion chambers, repeatability of sound levels may be affected. A cool down period of 5 min is recommended. Operate mobile earthmoving 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.

3.3.1.4 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, or the upper rotational structure of an excavator shall not be moved, or scraper elevator placed in operation during this stationary machine test.

3.3.2 Constant Speed Moving Test—Earthmoving machinery shall be

The φ 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.

Copyright © 1979 Society of Automotive Engineers, Inc.

SAENORM.COM : Click to view the full PDF of j919c_197904

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. Machines with hydrostatic, electric drive or other type drives shall 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 Earthmoving 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 160—320 mm (6—12 in) for dozers, scrapers, etc., and for loaders use the approximate carry position as described by SAE Standard J732c, Specification Definitions—Front End Loader.

3.4 **Measurements**

3.4.1 The microphone shall be located to the right of the operator's right ear or to the left of his left ear as stated in paragraph 3.2.4 for all operating conditions.

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

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 closed 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 rated engine speed shall be monitored during the rated speed test per paragraph 3.3.1.2.

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

3.4.7 The sound level meter needle movement, digital readout or graphic level recorder 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 if the maximum hold mode is being used. For the stabilized test condition, or maximum governed speed (high idle) or rated engine speed a single reading shall be recorded. For engine cycling, component cycling, and constant speed moving test conditions (paragraphs 3.3.1.3, 3.3.1.4, and 3.3.2), a minimum of three valid readings shall be taken for each measuring point. (In practice this is invisioned 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 mode 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 five test modes and cab configuration(s) in the format 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 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.

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

4.2.2 It is recommended that the wind speed of the air over the microphone not exceed 20 km/h (12.4 mph). Caution should be used in making measurements with higher wind speeds.

4.2.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems should be known.

4.2.4 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 the testing of each piece of earthmoving machinery or at least every 4 h. The calibration before and after shall not vary by more than ±0.5 dB for tests to be valid.

4.2.5 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 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 machines.

5. Reference Material

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

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

ANSI S1.4-1971 (R1976), Specifications for Sound Level Meters.

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

SAE Recommended Practice J1262, Sound Level Measurement Procedure for Trenching Equipment.

SAE Standard J245, Engine Rating Code—Spark Ignition.

SAE Standard J270, Engine Rating Code—Diesel.

SAE Recommended Practice J184a, 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 J1152, Minimum Performance Criteria for Brake Systems for Off-Highway Trucks and Wagons.

SAE Recommended Practice J1166a, Operator Station Sound Level Measurement Procedure for Earthmoving Machinery—Work Cycle Test.

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

The ANSI and ISO documents are available from: American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

SAENORM.COM : Click to view the full PDF of j1058_197901