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On-Machine Alarm Test and Evaluation Procedure for Construction
and General Purpose Industrial Machinery

Foreword—This document was uperceded by SAE J/ISO 9533.

- 1. Scope**—This procedure is intended for evaluating alarms on off-road self-propelled work machines while in a stationary, parked position.

This SAE Standard is similar to ISO/DIS 9533, Earthmoving machinery—Machine mounted morward and reverse warning alarm—Sound test method.

- 1.1 Purpose**—This SAE Standard outlines the procedures and sets criteria necessary to qualify an audible alarm when mounted on off-road self-propelled work machines as defined by SAE J1116 JUN86 (limited to categories 1. Construction, and 2. General Purpose Industrial).

- 1.1.1 The purpose of an alarm is to warn personnel of a potential hazard of a machine moving in reverse under its own power, without undue discomfort or irritation to the operator.
- 1.1.2 Alarm performance on the machine is a function of alarm design, condition, voltage at the alarm, and placement on the machine with respect to machine components. This procedure verifies that the combination of factors produce an audible alarm.

2. References

- 2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

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

SAE J88 JUN86—Sound Measurement—Earthmoving Machinery—Exterior
SAE J184 AUG87—Qualifying a Sound Data Acquisition System
SAE J732 FEB80—Specifications Definition—Loaders
SAE J833 DEC83—USA Human Physical Dimensions
SAE J994 MAR85—Alarm—Backup—Electric—Performance, Test and Application
SAE J1105 MAR85—Horn—Forward Warning—Electric—Performance, Test and Application
SAE J1116 JUN86—Categories of Off-Road Self-Propelled Work Machines

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2.1.2 ANSI PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI S1.4—Specification for Sound Meters

2.1.3 ISO PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8006.

ISO/DIS9533—Earthmoving machinery—Machinery mounted forward and reverse warning alarm—
Sound test method

3. General Comments

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

3.2 When making sound level measurements, not more than one person other than the test person reading the meter should be within 15 m (50 ft) of the machine or microphone, and that person shall be directly behind the test person reading the meter, on a line through the microphone and the test person. Because of the pure tone nature of most alarms, during measurements, the test person must be at least 3 m (10 ft) behind the microphone for exterior measurements.

3.3 Proper use of all test instrumentation is essential to obtain valid measurements. Operating manuals and 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:

3.3.1 The type of microphone, its directional response, and its orientation relative to the ground plane and sound source must be considered (reference manufacturer's recommendations).

3.3.2 Sound level measurements should be obtained within instrument performance limitations due to ambient weather conditions (for example, temperature, relative humidity, and barometric pressure).

3.4 The alarms must have first met the performance specifications, including sound level, of SAE J994 MAR85 or SAE J1105 MAR85. Operating conditions on the vehicle shall be verified to be equivalent to the appropriate specification if alarm levels are lower than expected. If alarm performance is not at desired levels, it will be up to the test person to determine if the alarm output is as expected.

4. Instrumentation

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

4.2 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 J184 AUG87, 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).

4.3 An acoustical calibrator (accuracy within ± 0.5 dB).

4.4 The use of a windscreen may be required under some test conditions. 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.

- 4.5 An anemometer or other device for measurement of ambient wind speed and direction (accuracy within $\pm 10\%$ at the highest recommended wind speed).
- 4.6 An engine speed indicator (accuracy within $\pm 2\%$ of the indicated speed).
- 4.7 A thermometer for measurement of ambient temperature (accuracy within $\pm 1^\circ\text{C}$ [1.8°F]).
- 4.8 A barometer for measuring atmospheric pressure (accuracy within $\pm 1.1\text{ kPa}$ [0.3 in Hg] of the indicated reading), if required for instrumentation used.

5. Procedure

5.1 Site-Environment, Machine Guidelines

- 5.1.1 The test area shall consist of a free field above a reflecting plane or semianechoic (hemianechoic) space. No reflective objects or surfaces such as buildings or hillsides should be located within 30 m (100 ft) of the microphone or the machinery being measured. The standard test site as described in SAE J88 JUN86 should be used to obtain consistency of data.
- 5.1.2 The ambient sound level due to sources other than the earthmoving machinery being measured (including wind effects) shall be at least 10 dB(A) lower than the lowest measurement of interest. The surface between and under the earthmoving machinery and the microphone shall be smooth and free of acoustically absorptive material, such as snow or grass.
- 5.1.3 Measurement shall not be conducted when precipitation is falling, snow is on the ground surface, or in winds above 20 km/h (12.4 mile/h). Environmental conditions shall be within the limits specified for the instruments used to obtain data.
- 5.1.4 Under prevailing conditions, the machine shall be at a stabilized temperature with the engine operating at high idle under no load with the transmission in neutral during the baseline machine sound test. When conducting the alarm test, it is permissible to have the engine operating at low idle rpm or shut off.
- 5.1.5 Major attachments should be mounted and in a normal carry position or 100 mm (4 in) above the ground (reference SAE J732 FEB80).
- 5.1.6 Measurements shall be taken and recorded at the points relative to the machine as indicated in Figure 1 (Machine Alarm Data Form).

5.2 Warning Alarm Measurement for Exterior Locations

- 5.2.1 For each measurement location, record the maximum reading obtained by moving the microphone with an appropriate manual or automated device (oriented with its long axis perpendicular to the plane of rotation) along the perimeter of a 230–300 mm (9–12 in) radius circle with its plane at 0–45 deg from vertical facing the tractor. A rotational rate of 60 s/rev ($\pm 15\text{ s}$) is preferred. The center of this circle should be $1.2 \pm 0.05\text{ m}$ ($47 \pm 2\text{ in}$) above ground level at the microphone locations shown in Figure 1 on the data sheet in the Appendix.

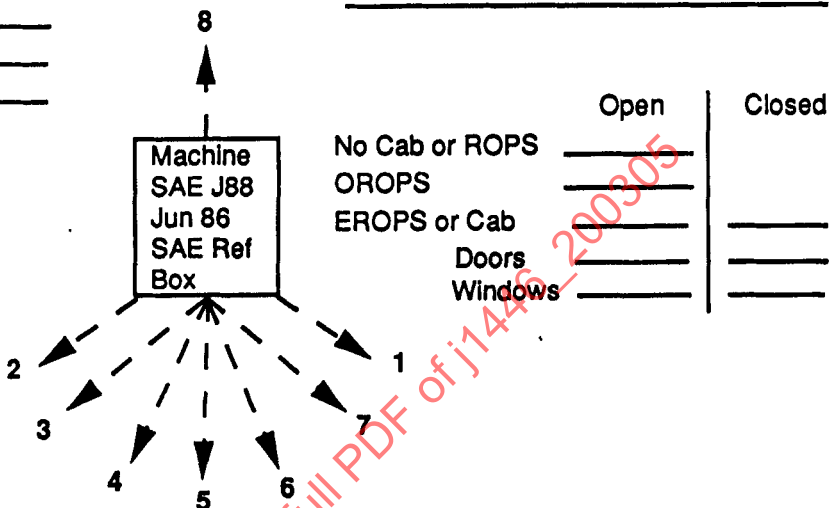
ALARM DESCRIPTION

	Backup	Forward
Manufacturer	_____	_____
Model No.	_____	_____
Type	_____	_____
Location on Machine	_____	

Microphone Elevation 1.2m
 300 mm Radius @
 _____ Vertical Angle

MACHINE DESCRIPTION

Model _____ S/N _____
 Max RPM _____
 Attachments _____



Loc.	Alarm Activated	Coordinates and Directions (Meters)		Measure From	Sound Level in dB(A)		
					Alarm OFF High Idle	Alarm ON Low Idle	Difference
1	Back Up	.7 Right	.7 Rear	Corner			
2	Back Up	.7 Left	.7 Rear	Corner			
3	Back Up	4.9 Left	4.9 Rear	Rear Center			
4	Back Up	2.7 Left	6.5 Rear	Rear Center			
5	Back Up	0	7.0 Rear	Rear Center			
6	Back Up	2.7 Right	6.5 Rear	Rear Center			
7	Back Up	4.9 Right	4.9 Rear	Rear Center			
8	Forward	0	7.0 Front	Front Center			
9	Back Up	Operator Location (250 mm Radius)		Ear Height			

Test Site and Surface Description _____

Temperature _____ Ambient Wind Speed _____

Remarks _____

Instrument Description _____

Date _____ Test Person _____

FIGURE 1—MACHINE ALARM SOUND LEVEL DATA SHEET

5.2.2 For the warning alarm tests at each location in Figure 1, measure and record the maximum sound levels for the following two conditions:

a. Base Machine

1. Sound level meter fast dynamic characteristic - A-weighted
2. Engine at maximum idle speed - no load
3. Alarm off

b. Alarm

1. Sound level meter fast dynamic characteristic - A-weighted
2. Engine at low idle speed - no load or off (verify adequate voltage)
3. Alarm on

(Calculate the "difference" in maximum reading of B minus A.)

5.3 Backup Alarm Procedures for Operator Location (Backup Alarm Only)

5.3.1 Measure and record the maximum sound level for base machine and alarm obtained by moving the microphone (oriented with its long axis perpendicular to the plane of rotation) around the perimeter of a 200–250 mm (8–10 in) radius circle with its plane horizontal and centered on the head of an average sized operator. (Reference SAE J833 DEC83). The microphone may be hand held by the test person in the operator location or swept in a circular path by a mechanical rotator positioned in the operator location. A rotational rate of 60 s/rev (± 15 s) is preferred.

5.4 Criteria

5.4.1 **BACKUP ALARM - EXTERIOR TEST**—The A-weighted sound level measured at any given test locations (Figure 1, locations 1–7) for the alarm test should be equal to or greater than the A-weighted sound level measured at the corresponding positions for the base machine at high idle no load.

5.4.2 **BACKUP ALARM - OPERATOR TEST**—The sound level measured at the operator location during the alarm test shall be no more than 3 dB(A) above the level measured for the base machine at high idle.

5.4.3 **FORWARD WARNING ALARM - EXTERIOR TEST**—As a general rule, the forward warning alarm sound level shall exceed that of the base machine by at least 10 dB(A) at location 8 on Figure 1. Appendix A contains a chart of known European criteria.

PREPARED BY THE SAE SOUND LEVEL TECHNICAL COMMITTEE—SOUND LEVEL WARNING ALARMS