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Superseding J1384 JUN1993

Vibration Performance Evaluation of Operator Seats

1. Scope—This SAE Standard describes a procedure for the evaluation of operator seats which may be fitted to agricultural wheeled tractors per SAE J1150 and/or earthmoving machines per SAE J1057. This procedure evaluates only the vertical vibration performance and should not be considered a comprehensive seat evaluation procedure.

1.1 Purpose—The purpose of this document is to establish a method for testing the seats of agricultural tractors and earthmoving machines. The method recognizes that the vibration performance of operator seats for agricultural tractors and earthmoving machines depends on the characteristics of the seat, the machine, and the operator. As such, this document describes a procedure utilizing human subjects (operators) for measuring and evaluating seat performance in the laboratory as a function of machine type and operator weight.

Agricultural wheeled tractors and earthmoving machines having similar vibration spectra are grouped into defined classes with corresponding test vibration input spectra specified for each class in SAE J1385 and SAE J1386. The specified power spectral density at the seat mounting base defines the response required from the vibration test stand during a given laboratory seat test.

The method measures the frequency weighted root mean square acceleration transmitted to the operator at the seat/buttock interface (whole body vibration) during simulated machine vibration on a vibration test stand or ride simulator. Performance for all applications within a defined class requires tests with subjects of specified weights.

1.2 Rationale—Superseded by ISO 5007.

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2. References

2.1 Applicable Publications—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 J1013 JAN80—Measurement of Whole-Body Vibration of the Seated Operator of Agricultural Equipment

SAE J1057 JUN81—Identification Terminology of Earthmoving Machines

SAE J1150 OCT92—Terminology for Agricultural Equipment

SAE J1163 JUN91—Determining Seat Index Point

SAE J1385 JUN83—Classification of Earthmoving Machines for Vibration Tests of Operator Seats

SAE J1386 JAN86—Classification of Agricultural Tractors for Vibration Tests of Operator Seats

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

ISO 2041-1990—Vibration and shock—Vocabulary

ISO/DIS 10326-1 (1992)—Mechanical vibration—Laboratory methods for evaluating seat vibration—
Part 1: Basic requirements

2.1.3 OTHER PUBLICATION

The Official Journal of the European Communities, No. L255/11, September 18, 1978

3. Definitions

3.1 Letter Symbols

a_z = the vertical component of acceleration (see Figure 1, SAE J1013)

rms = root-mean-square

a_{wf} = weighted rms acceleration calculated over the frequency range prescribed for the test input vibration using one of the methods as described in SAE J1013

a_{wfB} = a_{wf} at the base of the seat (7.3.2)

a_{wfS} = a_{wf} at the seat transducer disc (7.3.4)

PDF = Probability Density Function of acceleration amplitudes, generally Gaussian

PSD = Power Spectral Density expressed as mean square acceleration per unit bandwidth $(m/s^2)^2/Hz$

SIP = Seat Index Point (SAE J1163 JUN91)

OECD = Organization for Economic Cooperation and Development

3.2 Whole Body Vibration—Vibration transmitted to the body as a whole through the buttocks of a seated operator.

3.3 Agricultural Tractor Class—A group of agricultural wheeled tractors having similar vibration characteristics as defined in SAE J1386.

3.4 Earthmoving Machine Class—A group of earthmoving machines having similar vibration characteristics as defined in SAE J1385.

3.5 Operator Seat—That portion of the tractor or machine provided for the purpose of supporting the seated operator, including the seat suspension system, if any.

3.6 Suspension Oscillation Range—The vertical displacement of the suspended portion of the seat at approximately the fore and aft location of the SIP as the suspension is stroked from top-stop to bottom-stop, but not including any compression of the stops. Seat adjustments are to be in their center positions per Section 3 of SAE J1163.

3.7 Frequency Analysis—Process of arriving at a quantitative description of the amplitude of a vibration as a function of frequency.

4. Test Equipment

4.1 Instrumentation—Acceleration measuring equipment and procedures shall conform to SAE J1013. This document requires that the a_z component of acceleration be measured on the seat mounting base and at the seat/operator interface.

4.2 Vibration Test Stand

4.2.1 PHYSICAL CHARACTERISTICS—The minimum required facility is an electrohydraulic feedback control system with one degree of freedom along the direction of a_z . The system shall have a dynamic response capable of driving the mounting base of the loaded seat in accordance with the defined seat spectra.

The transfer function characteristics of the facility may be compensated for during the synthesis of the command input signal in order that a_z output PSD and PDF requirements are satisfied at the seat mounting base. Any appropriate digital or analog method may be used to generate the command signal providing the output PSD and PDF requirements are satisfied at the seat mounting base.

The moving portion of the vibration test stand shall consist of a platform to provide for the seat mounting base and flat floor space for operator foot support. The stand shall be constrained to travel in an essentially vertical direction and be free from resonances and nonlinearities which would distort the output vibration beyond the correction capability of signal compensation.

If the vibration test stand is of the pivoting type shown in Figure 1, the radius from the arm pivot to the SIP shall be at least 2000 mm, and the seat mounting base accelerometer shall be mounted the same distance (within ± 20 mm) from the pivot as the seat disc accelerometer. The following technical characteristics are only for the purpose of assisting in the selection of a vibration test stand.

- a. Working frequency range = 0.5 to 20 Hz.
- b. Piston stroke = 175 mm minimum (allowance for variable level at 0 Hz should be in addition to 175 mm).

4.2.2 SAFETY RECOMMENDATIONS—The vibration test stand should have fail-safe provisions capable of automatic shutdown when the seat mounting base acceleration exceeds 15 m/s^2 for any reason. (Maximum dynamic thrust force of $1.5 \times \text{mass of platform, seat, and subject}$.) It is preferred that this provision be a hydraulic means, such as a supply pressure relief valve and/or a load limiting valve across the piston of the actuator cylinder. If an acceleration transducer is used as the sensor for safety purposes, its signal should be passed through a low pass filter with a 20 Hz cutoff frequency to avoid automatic shutdown from high-frequency components beyond the hydraulic capability of the test stand. If the test stand is not of the hydraulic type, adequate safety devices should be used.