TC 43

TC 127

International Standard 6394

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Acoustics — Measurement of airborne noise emitted by earth-moving machinery — Operator's position — Stationary test condition

Acoustique — Mesurage du bruit aérien émis par les engins de terrassement — Poste de conduite — Condition d'essai statique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 6394 was prepared jointly by Technical Committees ISO/TC 43, *Acoustics*, and ISO/TC 127, *Earth-moving machinery*.

Acoustics — Measurement of airborne noise emitted by earth-moving machinery — Operator's position — Stationary test condition

0 Introduction

This International Standard is a special test code for specific types of earth-moving machinery. It is an extension of ISO 6081 which contains the general requirements for many types of machinery and equipment.

Specific requirements are provided in this special test code to enable the sound pressure level at the operator's position, with the machine in a stationary test condition, to be determined in a manner which is repeatable. Attachments (bucket, dozer, etc.) for the manufacturer's production version shall be fitted since this is the configuration most likely to exist when the machine is in actual use.

This International Standard will enable compliance with noise limits to be determined. It can also be used for evaluation purposes in noise reduction investigations.

An additional special test code is given in ISO 6393. This other special test code shall be used to determine the exterior noise emitted by earth-moving machinery in terms of the A-weighted sound power level while the machine is in a stationary test condition.

1 Scope

This International Standard describes a method for determining the noise emitted by earth-moving machinery at the operator's position in terms of the equivalent continuous A-weighted sound pressure level while the machine is in a stationary test condition.

2 Field of application

This International Standard is applicable to the following specific types of earth-moving machinery (see also the annex) : excavators (hydraulic or rope operated), crawler and wheel tractors with dozer equipment, and crawler and wheel loaders.

3 References

ISO 1585, *Road vehicles — Engines test code — Net power.*

ISO 3411, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope.*

ISO 6081, *Acoustics — Noise emitted by machinery and equipment — Guidelines for the preparation of test codes of engineering grade requiring noise measurements at the operator's position.* 1)

ISO 6165, *Earth-moving machinery — Basic types — Vocabulary.*

ISO 6393, *Acoustics — Measurement of airborne noise emitted by earth-moving machinery — Method for determining compliance with limits for exterior noise — Stationary test condition.*

IEC Publication 651, *Sound level meters.*

4 Definitions

For the purposes of this International Standard, the definitions given in ISO 6081 and the following definition apply.

equivalent continuous A-weighted sound pressure level, $L_{pAeq,T}$: The A-weighted sound pressure level averaged on an energy basis over the whole measurement period.

5 Instrumentation

5.1 General

For the purposes of this International Standard, the instrumentation specified in ISO 6081 applies. An additional requirement relating to the microphone is given in 5.2.

5.2 Microphone

A condenser microphone or the equivalent in accuracy, stability and frequency response shall be used. The external diameter of the microphone shall not exceed 13 mm so as to reduce possible directivity errors. The microphone and its associated cable shall be chosen so that the combined sensitivity does not change significantly over the temperature range encountered during the measurements.

1) At present at the stage of draft.

6 Test environment

For the purposes of this International Standard, the test environment specified in ISO 6393 applies.

7 Measurement of equivalent continuous A-weighted sound pressure levels

7.1 Operator

7.1.1 Operator presence

The operator shall be in the driving position and observers shall not be in close proximity or in the cab during measurements. The operator shall neither wear abnormally sound-absorptive clothing nor any hat or scarf (other than a protective helmet used for safety reasons or a helmet or frame used to support a microphone) which might influence the noise measurements.

7.1.2 Operator stature

The operator shall have a sitting height between 800 mm (small operator) and 960 mm (large operator) measured from the sitting surface to the top of the head, as specified in ISO 3411.

7.2 Seat adjustment

The seat shall be set at, or as near as possible to, the mid-point of its horizontal and vertical adjustment. Any seat suspension shall be depressed until the seat reaches the mid-point of its dynamic range.

7.3 Microphone

7.3.1 Microphone orientation

The microphone shall be oriented horizontally with its reference direction, as specified by the microphone manufacturer, pointing in the direction in which a person occupying the operator's seat would normally look.

7.3.2 Microphone position

The microphone shall be located 200 ± 20 mm from the median plane of the head and in line with the eyes and to the side of the head where the equivalent continuous A-weighted sound pressure level is highest.

7.3.3 *Microphone mounting*

The microphone can conveniently be mounted on a frame or on the helmet, or on a shoulder harness worn by the operator.

7.3.4 Microphone vibration precaution

Care shall be taken to isolate the microphone from vibrations which could affect the measurements. If the microphone is moved during the measurements, care shall be exercised to avoid introducing acoustical noise (for example, noise due to the microphone rubbing against the operator's clothing) or electrical noise (for example, due to a flexing cable) that could interfere with the measurements.

7.3.5 Microphone reflected noise precaution

Care shall be taken to minimize the effect of reflected noise which could affect microphone measurements. Although not a mandatory requirement, the following recommendation will minimize the effect of reflected noise.

7.3.5.1 After determining the microphone location, maintain a positional tolerance of ± 50 mm from this location in any direction during the test.

7.3.5.2 Place the microphone a minimum of 100 mm from the side of the head and a minimum of 50 mm above the clothing on the shoulder during the test.

7.4 Positioning of the machine

The machine shall be positioned at the centre of the test site surface.

7.5 Measurement time

The total measurement time for each reading in a stabilized operating mode shall be in the range of 15 to 30 s.

8 Definitions, setting-up and operation of machinery, and setting-up of operator's position

8.1 Definitions, setting-up and operation of machinery

See the annex.

8.2 Machine operating sequence

The engine shall be brought first to a low idle condition and then up to the manufacturer's specified rated speed at a stabilized no-load condition prior to each data-taking sequence.

8.3 Setting-up of operator's position

When the machine is equipped with a cab, the following rules shall be observed.

8.3.1 Cab with air conditioning and/or ventilating system(s)

Measurements shall be taken with the doors and windows closed and the air conditioning and/or ventilating systems operating at maximum speed.

8.3.2 Cab with no air conditioning nor ventilating system(s)

Measurements shall be taken with the doors and windows closed and repeated with the doors and windows open. The higher measurement result from the two sets of data obtained shall be used as the reported value.

9 Acoustic measurements

9.1 Measuring instrumentation

The preferred instrumentation system for acquiring the data shall be one that determines the equivalent continuous A-weighted sound pressure level with characteristics that will permit it to qualify for at least a type 1 accuracy in accordance with IEC Publication 651. The equivalent continuous A-weighted sound pressure level, $L_{pAeq,T}$, in decibels, shall be determined using the following equation :

$$L_{pAeq,T} = 10 \lg \left[\frac{1}{T} \int_0^T \frac{p_A^2(t)}{p_0^2(t)} dt \right] \quad \ldots (1)$$

where

T is the measurement period, i.e. the period of time for which the machine is operated during the test;

$p_A(t)$ is the instantaneous A-weighted sound pressure of the signal;

$p_0(t)$ is the reference sound pressure (= 20 μPa).

Alternatively, digital integration may be used to determine $L_{pAeq,T}$, in decibels, using the following equation :

$$L_{pAeq,T} = 10 \lg \left[\sum_{i=1}^{n} \frac{t_i}{100} \, 10^{0,1 L_{pAi}} \right] \quad \ldots (2)$$

where $\frac{t_i}{100}$ is the numerical value of the percentage of time for the sound pressure level, L_{pAi}, from the whole time interval, T, of the test, with the cell width for L_{pAi} being 1,0 dB or less.

NOTE — If a non-integrating sound level meter, type 1, is used, no reference to equivalent continuous type data can be made in all the recorded and reported information.

9.2 Number of measurements

A minimum of three measurements at the microphone position shall be required. It is necessary to have two of the readings at the microphone position within a 1 dB range of each other. If these results are not obtainable, additional readings shall be taken to meet this requirement.

10 Determination of measurement result

The reported value of the equivalent continuous A-weighted sound pressure level will be the arithmetic mean of the two highest values that are within a 1 dB range of each other.

11 Information to be recorded

11.1 Machinery under test

a) The machine manufacturer.

b) The machine model number.

c) The serial number.

d) The machine arrangement, including major attachments and the manufacturer's specified rated speed which is the speed at which the engine develops rated power in accordance with ISO 1585.

11.2 Acoustic environment

a) A description of the test site and the type of test site surface or surfaces used, including a sketch showing the position of the machine.

b) The air temperature, barometric pressure, relative humidity and wind velocity at the test site.

11.3 Instrumentation

a) The instrumentation used for the measurements, including name, type, serial number and manufacturer.

b) The method used to calibrate the instrumentation system.

c) The date and place of calibration of the acoustical calibrator.

11.4 Acoustical data

a) The location of the microphone.

b) The equivalent continuous A-weighted sound pressure level at the microphone position for each measurement conducted in accordance with 9.2.

c) The A-weighted sound pressure level of the background noise at the microphone position.

d) The reported value of the equivalent continuous A-weighted sound pressure level in accordance with clause 10.

12 Information to be reported

a) The equivalent continuous A-weighted sound pressure level from clause 10, rounded to the nearest whole number (< 0,5, use lower number; ⩾ 0,5, use higher number) for the configuration or configurations of operator's position depending on how the machine is equipped.

b) The machine manufacturer, model number, serial number, net power, in kilowatts, as defined in ISO 1585, machine arrangement, including major attachments and the type of test site surface or surfaces used.

c) The manufacturer's specified rated speed which is the speed at which the engine develops rated power in accordance with ISO 1585.