INTERNATIONAL STANDARD

ISO 6396

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Acoustics — Measurement at the operator's position of noise emitted by earth-moving machinery — Dynamic test conditions

Acoustique — Mesurage du bruit émis par les engins de terrassement au poste de conduite — Conditions d'essai dynamiques

Reference number
ISO 6396:1992(E)

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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 6396 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Sub-Committee SC 1, *Noise*.

Annex A of this International Standard is for information only.

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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.

A simulated dynamic rather than an actual work cycle test condition is chosen. Dynamic test conditions provide acceptable noise emission data which are repeatable and representative. Actual work cycle tests are complex and repeatability can be a problem.

Specific procedures are described in this International Standard to enable the sound pressure level at the operator's position, with the machine in a dynamic test condition, to be determined in a manner which is repeatable. Attachments (bucket, dozer, blade, etc.) for the manufacturer's production version are to be fitted since this is the configuration most likely to exist when the machine is in actual use.

This International Standard enables 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 6395. This other special test code is intended to be used to determine the noise emitted by earth-moving machinery in terms of the A-weighted sound power level while the machine is in a dynamic test condition.

Corresponding measurements of noise emitted to the environment and noise at the operator's position under stationary test conditions are described in ISO 6393 and ISO 6394, respectively.

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Acoustics — Measurement at the operator's position of noise emitted by earth-moving machinery — Dynamic test conditions

1 Scope

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

This International Standard is applicable to the following specific crawler and wheeled types of earth-moving machinery:

— excavators (hydraulic or rope-operated) (see figure 1),

— tractors with dozer equipment (see figure 2),

— loaders (see figure 3), and

— backhoe loaders (also known as excavator-loaders) (see figure 4).

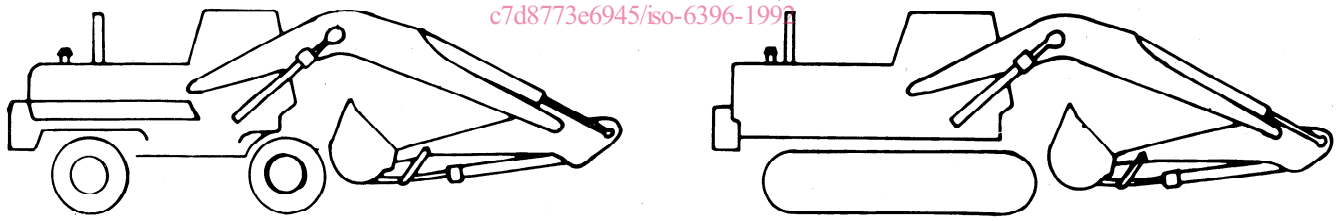

Figure 1 — Excavator

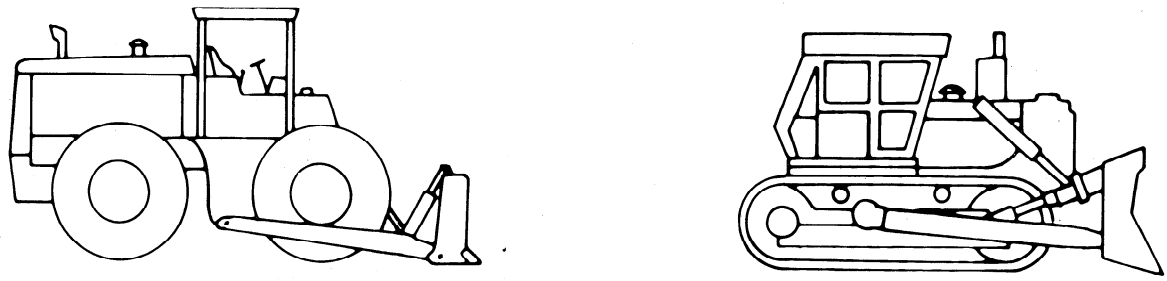

Figure 2 — Tractor with dozer attachment

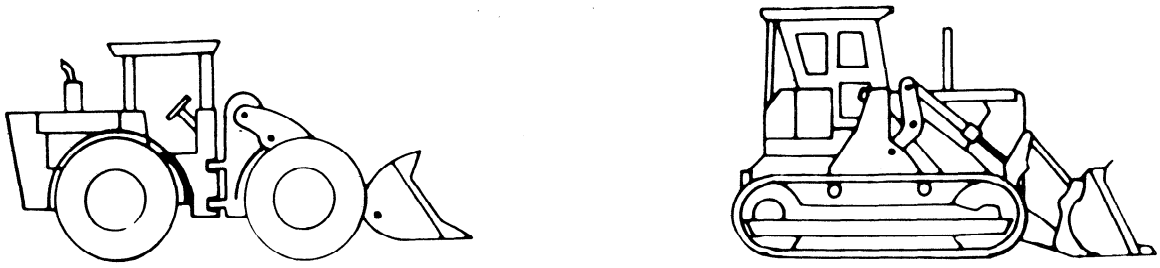

Figure 3 — Loader

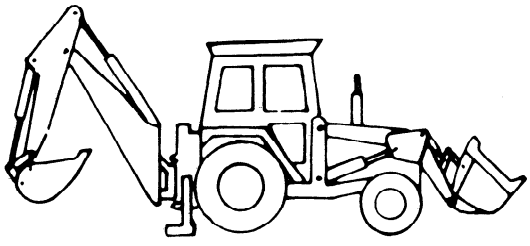

Figure 4 — Backhoe loader

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1585:1982, *Road vehicles — Engines test code — Net power.*

ISO 3411:1982, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope.*

ISO 6081:1986, *Acoustics — Noise emitted by machinery and equipment — Guidelines for the preparation of test codes of engineering grade requiring noise measurements at the operator's or bystander's position.*

ISO 6395:1988, *Acoustics — Measurement of exterior noise emitted by earth-moving machinery — Dynamic test conditions.*

IEC 651:1979, *Sound level meters.*

IEC 804:1985, *Integrating-averaging sound level meters.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 6081 and ISO 6395 and the following definition apply.

3.1 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. It is expressed in decibels.

4 Instrumentation

The instrumentation shall be capable of carrying out measurements as described in 8.1. Integrating-averaging sound level meters shall meet the requirements of IEC 804 for a type 1 instrument. Alternative instrumentation, including the microphone and cable, shall meet the requirements of IEC 651 for a type 1 instrument.

An omnidirectional microphone shall be used for measurements 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.

5 Test environment

The test environment shall be as specified in ISO 6395.

NOTE 1 If limitation of space is a problem, the use of a smaller test site is permissible. The minimum perimeter of the smaller test site is determined by the length of the travel path and the width of the machine. Sufficient tolerance should be allowed on the length and width of the smaller test site to ensure that machine is always within the perimeter of operating site surface during travel.

6 Measurement of equivalent continuous A-weighted sound pressure levels

6.1 Travel path and positioning of the machine

The travel path, travel path length and position of the machine shall be as specified in ISO 6395.

6.2 Operator

6.2.1 Presence of operator

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 wear neither 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.

6.2.2 Stature of operator

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.

6.3 Seat adjustment

The seat shall be positioned at, or as near as possible to, the mid-point of its horizontal and vertical adjustment. Any seat suspension shall be depressed so that the seat is at the mid-point of its dynamic range.

6.4 Microphone

6.4.1 Orientation of microphone

Unless otherwise stated by the manufacturer of the microphone, the microphone shall be oriented horizontally pointing in the direction in which a person occupying the operator's station would normally look.

6.4.2 Position of microphone

The microphone shall be located 200 mm ± 20 mm from the median plane of the head of the operator and in line with the eyes, first on the left side and then on the right side of the head of the operator during the maximum governer engine speed (high idle) condition with the machine in a static mode, as a preliminary sound pressure level data check point. Whichever side yields the highest reading shall be used for the dynamic check. If both initial sound pressure level checks are the same, the right side location shall be used.

6.4.3 Mounting of microphone

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

6.4.4 Precautions against vibrations

Care shall be taken to insulate 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.

6.4.5 Precautions against reflected noise

6.4.5.1 Care shall be taken to minimize the effect of reflected noise which could affect microphone measurements; accordingly, as far as practicable, ensure that the provisions specified in 6.4.5.2 and 6.4.5.3 are complied with.

6.4.5.2 After determining the microphone location, maintain a positional tolerance of ± 100 mm from the location in any direction during the test.

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

7 Setting-up and operation of machinery, and setting-up of operator's position

7.1 Setting-up and operation of machinery

For the purposes of this International Standard, the setting-up and operation of machinery specified in ISO 6395 apply.

7.2 Setting-up of operator's position

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

7.2.1 Cab with an air conditioning and/or pressurized ventilating system(s)

Measurements shall be taken with the doors and windows closed. If more than two operating speeds are available, the air conditioning and/or pressurizing ventilating system(s) shall be operated at mid-range speed; if only two operating speeds are available, the higher speed shall be used. If the air conditioning and/or pressure ventilating system(s) has (have) a recirculation and outside air position, the control shall be set for outside air.

Care shall be taken to ensure that air flow from the ventilation system does not produce any wind effects on the microphone.

7.2.2 Cab with no air conditioning nor pressurized ventilating system(s)

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

8 Acoustic measurements

8.1 Measuring instrumentation

The preferred instrumentation system for acquiring the data is an integrating-averaging sound level meter complying with the requirements of IEC 804 for a type 1 instrument. The equivalent continuous A-weighted sound pressure level $L_{pAeq,T}$, in decibels, is determined either by using the following equation:

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

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 is the reference sound pressure (20 μPa);

or, alternatively, by digital integration using the following equation:

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

where

$t_i/100$ 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

L_{pAi} are the values of the A-weighted sound pressure level obtained with instrumentation complying with the requirements of IEC 651 for a type 1 instrument and set for the time-weighting characteristic S.

8.2 Number of dynamic cycles

Three dynamic cycles shall be carried out resulting in three measurements to be taken at the microphone position. In order to meet the requirements laid down in clause 9, additional cycles may be necessary.

9 Determination of measurement result

If the three values obtained according to 8.2 do not differ by more than 1 dB, further measurements are not necessary. If this is not the case, continue measurements until two values are obtained within a range of 1 dB of each other.

Report, as the value of the equivalent continuous A-weighted sound pressure level, the arithmetic mean of the two highest values that are within a range of 1 dB of each other.

10 Information to be recorded

10.1 Machinery under test

The following information shall be recorded:

a) the machine manufacturer;

b) the machine model number;

c) the serial model;

d) the machine arrangement, including major attachments, the engine speed at maximum governor position (high idle) and the gear ratios or control settings.

10.2 Acoustic environment

The following information shall be recorded:

a) a description of the test site and the type of test site measurement surface used, including a sketch showing the position of the machine;

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

10.3 Instrumentation

The following information shall be recorded:

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.

10.4 Acoustical data

The following information shall be recorded:

a) the location of the microphone in relation to the operator's ear, and the presence or absence of any object which may influence the operator's noise exposure (such as a protective helmet);

b) the equivalent continuous A-weighted sound pressure level at the microphone position for each measurement carried out in accordance with clauses 6 to 8;

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 9.

11 Information to be reported

The following information shall be reported:

a) the equivalent continuous A-weighted sound pressure level from clause 9, rounded to the nearest whole number (< 0,5, use lower number; ⩾ 0,5, use higher number) for the configuration(s) 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 measurement surface used;

c) the engine speed at maximum governor control position (high idle) with the machine stationary and transmission in neutral.