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**Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria**

*Engins de terrassement — Avertisseurs sonores de déplacement et de recul montés sur engins — Méthodes d'essai et critères de performance*

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9533 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

This second edition cancels and replaces the first edition (ISO 9533:1989), which has been technically revised. Notably, test methods and criteria have been modified to include the evaluation of self-adjusting sound level alarms and travel warning alarms.

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# Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria

## 1 Scope

This International Standard specifies a static method for determining the sound output performance and alarm activation requirements of audible travel alarms and forward horns mounted on earth-moving machinery, as defined in ISO 6165, for operation on work sites and travelling on public roads. It offers objective test methodologies and performance criteria.

It is applicable only to those alarms and horns that are installed on the earth-moving machinery. It does not specify the installation of one or more audible travel alarms or forward horns on particular machines. It addresses neither the laboratory testing of warning alarm functionality nor durability.

NOTE Earth-moving machine manufacturer's practices, worksite requirements and local, national or regional regulations could require the fitting of the alarms or horns specified in this International Standard.

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## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 6746-1, *Earth-moving machinery — Definitions of dimensions and codes — Part 1: Base machine*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### machine reference box

##### MRB

imaginary rectangular box that would just fit over the base machine according to ISO 6746-1, which excludes all equipment and attachment items such as buckets, dozers, backhoes, rippers and booms

### 3.2

#### audible travel alarm

machine-mounted audible alarm intended to warn or alert personnel of the potential hazard of the machine travelling under its own power

3.2.1

**travel warning alarm**

audible signal intended to warn or alert personnel, especially those near a machine, that the machine has been activated to travel under its own power

NOTE These alarms are normally associated with machines that have rotating upper structures.

3.2.2

**reverse warning alarm**

audible signal intended to warn personnel, especially those near the rear of a machine, that the machine has been activated to travel in a rearward direction under its own power

3.3

**forward horn**

audible signal activated by the operator of the machine intended to alert personnel near a machine, but especially near the front of the machine

NOTE A forward horn or horns can also be used as part of a theft or security alarm system for the machine.

3.4

**fixed sound level alarm**

audible travel alarm that produces a sound level independent of ambient sound levels

3.5

**self-adjusting sound level alarm**

audible travel alarm that automatically adjusts its sound level, throughout a defined range, in order to maintain a sound level differential between the output of the alarm and the ambient sound level measured by the alarm

3.6

**ambient sound**

all sounds in the test area not produced by the audible travel alarm(s)

3.7

**free field**

space with no reflecting surface within 30 m of the sound source or microphone in any direction except for the horizontal reflecting plane on which the test machine is located

## 4 Apparatus

**4.1 Sound level meter** with an extension cable or equivalent sound measurement system that meets the performance requirements of IEC 61672-1, Type 1.

It is recommended that for the purposes of this International Standard all sound pressure level measurements be rounded to the nearest whole number in decibels.

**4.2 Acoustical calibrator**, or equivalent measurement system, recommended to be used each day of measurement to calibrate the sound level meter prior to testing and for checking sensitivity drift after test completion. The effects of atmospheric pressure, temperature and use of a windscreen should be accounted for within the system calibration as recommended by the manufacturer of the instrumentation.

**4.3 Microphone wind screen**, designed for sound measurement and recommended by the manufacturer of the sound level meter or equivalent sound measuring system, which shall be used to maintain consistency from test to test and add protection to the microphone assembly.

**4.4 Anemometer**, or other device, for measuring ambient wind speed and direction, accurate to within  $\pm 10\%$  at the highest recommended wind speed.

**4.5 Engine rotational frequency indicator** with an accuracy to within  $\pm 2\%$  of the indicated engine rotational frequency.

**4.6 Thermometer** for measurement of ambient temperature accurate to within  $\pm 2\text{ }^{\circ}\text{C}$ .

NOTE Apparatus will also be needed for checking the test environment (see 5.1).

## 5 Test environment

### 5.1 Test area

The test area shall consist of a free field above a hard reflecting plane no rougher than non-porous asphalt. The test area bordered by the machine and the microphone shall also consist of a flat, horizontal surface or surface sloping downwards away from the centre of the test area. No reflective objects such as buildings should be within 30 m of the microphone or the machine being measured.

The test technician or test equipment shall be  $> 2$  m from the sound-measuring microphone during exterior location measurements.

NOTE For further details giving the recommended test area configuration, see ISO 3744 and ISO 6393.

### 5.2 Background noise

The ambient A-weighted sound pressure level due to sources other than the earthmoving machinery under test, including wind effects, shall be at least 10 dB lower than the lowest measurement of interest.

### 5.3 Climatic conditions

Measurements shall not be carried out when precipitation, e.g. rain, snow or sleet, is falling or when the ground is snow-covered. The ambient temperature shall be within a temperature range  $-10^{\circ}\text{C}$  to  $+35^{\circ}\text{C}$ .

NOTE For further details giving recommended climatic conditions, see ISO 6393.

### 5.4 Wind

The average wind speed at the test site shall be less than 8 m/s.

Wind speeds at each measurement location due to machine operation should also be below 8 m/s. For measurement locations where wind speeds are above this value, sound measuring equipment designed for high wind applications should be used.

## 6 Machine preparation

### 6.1 Voltage

Verify that the alarm activation voltage to the audible travel alarm(s) or forward horn is within the nominal operating voltage specified by the manufacturer of the travel warning alarm(s) or forward horn.

### 6.2 Engine and transmission

#### 6.2.1 General

Under prevailing conditions, the machine shall be at a stabilized temperature for all its primary power systems at maximum governor engine speed (high idle).

### 6.2.2 Cooling system fan speed(s)

If the powertrain or hydraulic system or systems of the machine are fitted with an adjustable fan or fans, they shall operate during the test at maximum achievable fan speed at the engine speed as specified in Clause 7.

If equipped with an electric fan or fans, these shall be off when taking sound pressure measurements with the engine off.

### 6.3 Equipment and attachments

For testing, the equipment and attachment(s) for the most typical machine configuration as specified by the machine manufacturer shall be installed and in the carry position for travelling (see ISO 5006). The attachment position shall also be as specified by the manufacturer.

### 6.4 Operator station

#### 6.4.1 Heating, ventilation and air-conditioning system

If the operator station is equipped with a heating, ventilation and air-conditioning (HVAC) system or systems, these shall be set to mid-setting during all tests, defined below. The ventilation ducts shall be open with the air flow directed out but away from the operator.

- For an Off/Low/High system, at mid-setting the HVAC fan setting(s) will be at “High”.
- For an Off/Position 1/Position 2/Position 3 system, the mid-setting will be Position 2.
- For a continuously variable system, the mid-setting is at or above 50 % of the maximum fan speed.

If the HVAC system consists of multiple systems, e.g. separate upper and lower controls, all systems shall be set to mid-setting.

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NOTE For further details on fan speed and fan settings, see ISO 6393.

#### 6.4.2 Operator size and location

For testing at the location of the operator, an operator should be selected whose physical dimensions are as close as possible to a medium operator, and within the limits for a small to a large operator, as defined in ISO 3411.

The seat shall be positioned in the mid-position for fore and aft and for vertical height, if adjustment is provided. The seat and head rest, if present, shall be adjusted to accommodate the operator and shall remain consistent during the test series.

#### 6.4.3 Additional considerations

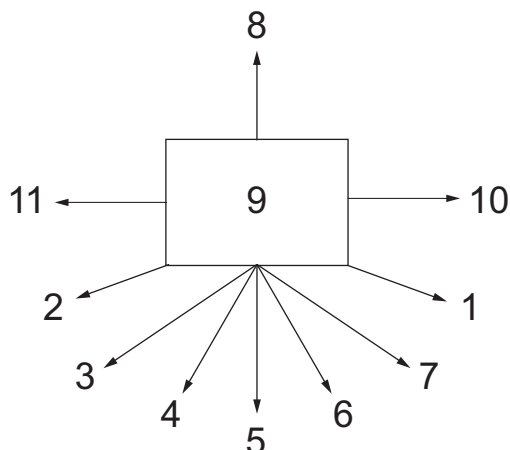
Other considerations for the operator station include eliminating non-typical machine noise such as radios and monitor alarms. For cab units, all windows and doors shall be closed. Cab interior materials and seals should be typical of the machine type and family.



## 7 Test procedures

### 7.1 General

Measurements shall be taken and recorded at the alarm and horn test measurement locations shown in Figure 1 and in accordance with Table 1.



The rectangle represents the machine reference box (MRB) and the numbers indicate the test measurement locations. See Table 1.

NOTE Not drawn to scale.

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**Figure 1 — Test measurement locations in relation to MRB**

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**Table 1 — Test measurement locations in relation to MRB**

Location <sup>a</sup>	Coordinates: distance and direction m				As measured from
1	0,7	Right	0,7	Rear	Right rear corner
2	0,7	Left	0,7	Rear	Left rear corner
3	4,9	Left	4,9	Rear	Rear centre
4	2,7	Left	6,5	Rear	Rear centre
<b>5</b>	<b>0,0</b>	<b>Centre</b>	<b>7,0</b>	<b>Rear</b>	<b>Rear centre</b>
6	2,7	Right	6,5	Rear	Rear centre
7	4,9	Right	4,9	Rear	Rear centre
8	0,0	Centre	7,0	Front	Front centre
9	Location of operator				Ear height
<b>10</b>	<b>0,0</b>	<b>Centre</b>	<b>7,0</b>	<b>Right</b>	<b>Right-side centre</b>
<b>11</b>	<b>0,0</b>	<b>Centre</b>	<b>7,0</b>	<b>Left</b>	<b>Left-side centre</b>

NOTE Text in **bold italic** indicates travel warning alarm test points.

<sup>a</sup> As per Figure 1.

An optional test method using 1/3<sup>rd</sup> octave bands to evaluate warning alarm performance is given in Annex C.

## 7.2 Setup for exterior alarm measurements

All sound measurements should be taken with the sound level meter set to “Fast response time weighting”, as defined in IEC 61672-1.

Sound measurements shall be taken for a minimum duration of 1 min at each test measurement location. When testing forward horns, such as electro-mechanical horns, sound measurements should not exceed a 1 min activation time without a pause between activations. The length of this pause should be specified by the horn manufacturer. Sound measurements performed on forward horns can be taken in minimum increments of 30 s.

The centre point of the measurement location should be  $1,2\text{ m} \pm 0,05\text{ m}$  from the ground with the normal to the rotational plane at  $0^\circ$  to  $45^\circ$  up from horizontal and facing the centre line of the MRB. The microphone should be held perpendicular to this plane and a minimum distance of 2 m shall be maintained by the test technician performing the measurement. See Figure 2.

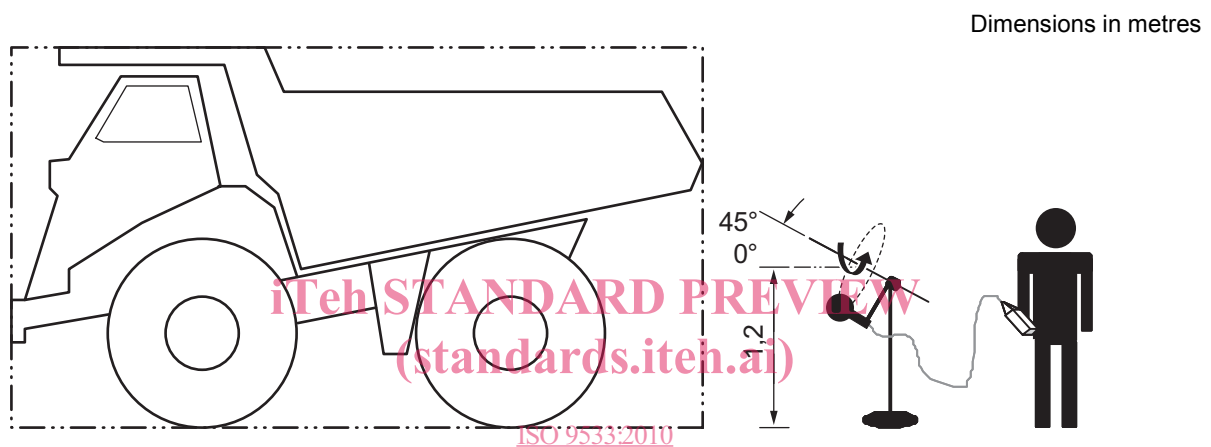


Figure 2 — Typical measurement setup for exterior alarm measurement

An approximate rotational rate of 2 r/min should be used to traverse the microphone along the 260 mm radius circle during the measurements.

An apparatus can be used to measure the sound along the perimeter of a  $260\text{ mm} \pm 25\text{ mm}$  radius circle as shown in Figure 2. A description of how to build such an apparatus is given in Annex B.

## 7.3 Audible travel alarm and forward horn measurement

### 7.3.1 Reverse warning alarms — Exterior test

#### 7.3.1.1 General

At test measurement locations 1 to 7, measure and record the maximum overall sound pressure level using either method 1 or 2, as specified below.

#### 7.3.1.2 Method 1 — Fixed sound level alarms

##### — Alarm Off

Capture the maximum sound pressure level with the reversing alarm off and the engine at maximum governor engine speed (high idle).

##### — Alarm On

Capture the maximum sound pressure level with the reversing alarm on and the engine at low idle or with the engine switched off.

### 7.3.1.3 Method 2 — Self-adjusting sound level alarms

#### — Alarm Off

Capture the maximum sound pressure level with the reversing alarm off and the engine at maximum governor engine speed (high idle)

#### — Alarm On

Capture the maximum sound pressure level with the reversing alarm on and the engine at maximum governor engine speed (high idle).

### 7.3.2 Travel warning alarm measurement — Exterior test

#### 7.3.2.1 General

At test measurement locations 5, 10 and 11, measure and record the maximum overall sound pressure level as specified below.

For machine types with their operator's station on the left-hand side of the machine (test measurement location 11), test measurements shall be taken and recorded at least at locations 5 and 10 for the maximum overall sound pressure level as defined below.

#### 7.3.2.2 Method 1 — Fixed sound level alarms

#### — Alarm Off

Capture the maximum sound pressure level with the travel warning alarm off and the engine at maximum governor engine speed (high idle).

#### — Alarm On

Capture the maximum sound pressure level with the travel warning alarm on and engine at low idle or with the engine off.

#### 7.3.2.3 Method 2 — Fixed sound level or self-adjusting sound level alarms

#### — Alarm Off

Capture the maximum sound pressure level with the travel alarm off and engine at maximum governor engine speed (high idle).

#### — Alarm On

Capture the maximum sound pressure level with the travel alarm on and engine at maximum governor engine speed (high idle).

If the travel alarm is also used as the primary reverse warning alarm, the tests and criteria given in 7.3.1 also apply.

### 7.3.3 Forward horn measurement — Exterior test

At test measurement location 8, measure and record the maximum overall sound pressure level as specified below.

#### — Horn Off

Capture the maximum sound pressure level with the forward horn off and the engine at maximum governor engine speed (high idle).