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## Earth-moving machinery — Operator's controls

*Engins de terrassement — Commandes de l'opérateur*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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

This third edition cancels and replaces the second edition (ISO 10968:2004), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the document has been reorganized for easier interpretation;
- minimum and normal actuating forces have been removed;
- state-of-the-art solutions have been taken into account.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document specifies design criteria for operator controls on earth-moving machinery. As machines have gone through significant developments since the first edition of ISO 10968 in 1995, this document covers both legacy machines and state-of-the-art solutions. This needs to be taken into account when reading the annexes.

As attachments and controls are becoming more advanced, it was considered important to reorganize the document for easier interpretation whereby base machine, equipment and attachments were separated in different annexes. As graders and dozers often have unique operator controls, it was also decided to separate these two machine types into separate annexes.

Other important changes made in the third edition include the removal of minimum and normal actuating forces for operator controls. It was considered that as there is a large variation in actuating forces for different types of controls, providing standardized actuating forces was not feasible. Instead, the manufacturer has to ensure that minimum actuating forces are enough to prevent inadvertent activation.

While preparing this document, it was noted that levers are developing rapidly and there are large differences even within a given machine family, for example excavators. The document therefore tries to also account for the most advanced excavators, whereby more controls are added to levers in order to allow for more functionality. Nothing in this document is to discourage the development of new technologies and new technical measures as the state-of-the-art changes in order to improve the operation of earthmoving machinery.

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# Earth-moving machinery — Operator's controls

## 1 Scope

This document specifies requirements and guidelines for the operator's controls on earth-moving machinery as defined in ISO 6165, in as far as those controls relate to any direct-control machine. The recommendations given for finger-, hand- and foot-operated controls are not intended to prevent usage of other types of controls, control locations or control movements. This document is not applicable to devices which are not directly related to machine control.

NOTE For remote operator control of machines, see ISO 15817.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3450, *Earth-moving machinery — Wheeled or high-speed rubber-tracked machines — Performance requirements and test procedures for brake systems*

ISO 5010, *Earth-moving machinery — Rubber-tyred machines — Steering requirements*

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

ISO 6405-1, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 6405-2, *Earth-moving machinery — Symbols for operator controls and other displays — Part 2: Symbols for specific machines, equipment and accessories*

ISO 10265, *Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems*

ISO 17063, *Earth-moving machinery — Braking systems of pedestrian-controlled machines — Performance requirements and test procedures*

## 3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### control

device actuated by an operator to affect a response from the machine

### 3.2

#### **primary control**

control that is used continuously by the operator

Note 1 to entry: The primary controls are the following:

a) For the base machine:

- steering;
- clutch or inch pedal;
- gear selection;
- speed (engine or ground speed);
- travel direction;
- brakes;
- swing of upper structure.

b) For equipment:

- swing operation;
- raising/lowering operation (e.g. loader arm, dozer blade or ripper, excavator boom, side boom winch, rope excavator winch);
- boom/arm extending/retracting;
- rearward/forward motion;
- boom sideshift (e.g. sideshift carriage of the backhoe linkage);
- boom fold/unfold;
- boom offset.

c) For attachments:

- attachment operation (e.g. bucket, tiltrotator, clamshell, forks);
- rotation operation (e.g. tiltrotator where the position of the attachment is changed as opposed to the functional rotation of a tool as in an auger);
- tilting operation;
- hydraulic breakers.

### 3.3

#### **secondary control**

control that is infrequently used by the operator but is needed for the proper functioning of the machine

EXAMPLE Control for parking brake, for lighting controls, mode selection, quick coupler control, stabilizer control.

### 3.4

#### **earth moving machine response**

movement of base machine or equipment or attachment in response to activation of a control

EXAMPLE Raising of the bucket when the bucket lift control is moved to the raise position, closing of a clamshell when the clamshell close control is moved to the close position.

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**3.5****base machine**

earthmoving machine with a cab or canopy and operator protective structures, if required, without equipment or attachment but possessing the necessary mounting for such equipment and attachments

[SOURCE: ISO 6746-2:2003, 3.3]

**3.6****equipment**

set of components mounted on to the base machine that allows an attachment to perform the primary design function of the machine

[SOURCE: ISO 6746-2:2003, 3.4]

**3.7****attachment**

assembly of components that can be mounted on the base machine or equipment for specific use

[SOURCE: ISO 6746-2:2003, 3.5]

**3.8****proportional control**

control that allows continuously variable, or modulated, control of the base machine, equipment, or attachment functions

**3.9****remote operator control**

operator control of a machine by wireless or wired transmission of signals from a remote control box not located on the machine to a receiving unit located on the machine

[SOURCE: ISO 15817:2012, 3.7]

**3.10****control actuating force**

force required at the centre of the control contact surface, in the direction of the intended movement of the control, in order to activate a control function

Note 1 to entry: This force does not necessarily represent the force typically applied by the operator.

**3.11****lever**

arm or handle that is moved by the operator's hand to control a function or functions of a machine

**3.12****single lever control**

lever movable in one axis that controls the described function

**3.13****two lever control**

two single lever controls that, in combination, control the described function

**3.14****multifunctional control, two-axis**

lever movable in axes a-b + c-d that controls the described function

Note 1 to entry: See [Figure 1](#).

**3.15****multifunctional control, four-axis**

lever movable in axes a-b + c-d + e-f + g-h that controls the described function

Note 1 to entry: See [Figure 1](#).

3.16

**button**

control that is pressed to release or activate a function

3.17

**dial**

control that is rotated in order to operate a function

3.18

**pedal**

exclusively foot-operated control

3.19

**single pedal control**

pedal movable in one axis, that controls the described function

3.20

**two pedal control**

two pedals that, in combination, control the described function

**4 Requirements for controls**

**4.1 General**

This document recommends that the general requirements and principles of arrangement be followed for other types of controls apart from the one's listed below, taking into account operator safety and ergonomics.

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**4.2 Control locations**

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The location of primary controls shall be within the minimum operator space envelope as given in ISO 3411. Primary and secondary controls should also take into account the guidelines given in ISO 6682.

**4.3 Distance between controls**

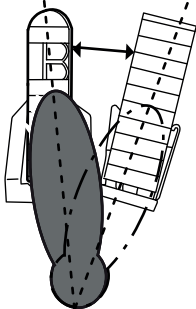
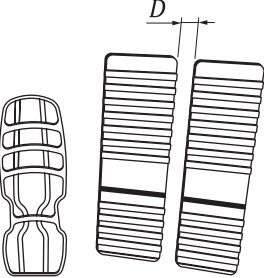
The distance between adjacent controls and between controls and other machine parts shall be sufficient to allow operation without unintentional activation of adjacent controls. The overlapping of controls is permissible to provide independent and simultaneous control application.

4.3.1 The minimum distance between finger-, hand- and foot-operated controls, or between these types of controls and other machine parts, shall be in accordance with [Table 1](#):

**Table 1 — Distance between controls**

Type of control	Minimum distance between two adjacent controls
Finger-operated controls	23 mm, without divider (distance between centre line of adjacent controls) 18 mm, with divider (distance between centre line of adjacent controls) For keys located on a touch screen or buttons on a lever: 14 mm (distance between centre line of adjacent controls)
Hand-operated controls	40 mm (clearance between two adjacent controls)

Table 1 (continued)

Type of control	Minimum distance between two adjacent controls
Foot-operated controls	<p>For pedals not intended to be used simultaneously:</p> <p>50 mm (clearance between two adjacent controls) for controls intended to be operated with separate feet or same foot but different heel points.</p> <p>30 mm (clearance between two adjacent controls) for controls intended to be operated with the same foot and from the same heel position (e.g. accelerator pedal and brake pedal). These controls shall not be parallel to each other.</p> <p>Exception: adjacent controls may be parallel to each other provided there is a minimum 30 mm distance between the planes of the operating surfaces. These types of controls are not intended to be used simultaneously.</p> 
Type of control	Maximum distance between two adjacent controls:
Foot-operated controls	<p>For pedals intended to be used simultaneously:</p> <p>Maximum 30 mm (clearance between two adjacent controls) for controls intended to be operated with the same foot and from the same heel position and the controls (e.g. the throttle controls on a self-propelled scraper with two separate engines). The pedals may be parallel.</p> 

4.3.2 If two adjacent finger- or hand-operated controls are intended to be used simultaneously, a smaller distance is acceptable.

4.4 Measures against movement or damage by external forces

Controls, control linkage and their power supply shall be arranged such that they cannot be damaged or moved into an undesirable position by foreseeable external forces, e.g. hand or foot force or shaking (vibration) of the machine.

4.5 Pedals

The surface of pedals shall be slip-resistant.

## 5 Movement of controls

### 5.1 General

The type, location and method of operation of typical primary controls are specified in [Annex A](#) for base machine movements, in [Annex B](#) for equipment movements and in [Annex C](#) for attachment movements. Specific requirements for graders are found in [Annex D](#). Specific requirements for dozers are found in [Annex E](#). Primary controls for equipment not otherwise specified should follow the same principles as given by [Annex B](#). Primary controls for attachment not otherwise specified should follow the same principles as given by [Annex C](#).

**5.1.1** The movement of the controls in relation to their neutral position shall be in the same general direction as the machine response, unless the combining of controls or customary usage dictates otherwise (e.g. driving control of machines where the operator's position is located on the part of the machine that can swing, such as the upper structure of an excavator).

**5.1.2** If a machine is equipped with an alternative operator's position with duplicated control arrangements, then both sets of controls shall operate in the same manner. When one set of controls is active, the other set shall be inactive. The active set shall be clearly identified with a visual indicator. An exception would be for mechanically connected dual controls (e.g. duplicate steering wheels, duplicated propulsion controls) where all controls are continuously active.

**5.1.3** All controls shall return to their neutral position when the operator releases the control, unless the control has a detent or hold position or continuously activated position.

**5.1.4** For foot-operated controls where the pedal is operated in two directions, e.g. downward motion of the front of the pedal and downward motion of the rear of the pedal, the pedal shall pivot under the operator's foot and shall remain at rest in the neutral position.

**5.1.5** The controls shall be so arranged or deactivated or guarded that they cannot be activated unintentionally — in particular e.g. when the operator is getting into or out of the operator's station according to the manufacturer's instructions.

**5.1.6** The controls shall be arranged so as not to create a tripping hazard when the operator is getting into or out of the operator's station according to the manufacturer's instructions.

**5.1.7** For gear/drive/speed selection controls the shifting pattern shall be clearly marked. In particular, the neutral position shall be clearly identified.

**5.1.8** The identification symbols shall be on the controls or next to them. If space limitations dictate, a diagram showing the primary controls is acceptable: it shall be easily visible to the operator.

**5.1.9** Graphical symbols shall be in accordance with ISO 6405-1 and ISO 6405-2.

### 5.2 Multifunctional controls

#### 5.2.1 General

In the case of a multifunctional control used to control the operations of the base machine, equipment or attachments, either separately or in combination, the following applies in addition to [5.1](#).

#### 5.2.2 Basic movement of multifunctional controls

The basic movements of multifunctional controls consist of the control movements illustrated in [Figure 1](#).