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Earth-moving machinery — Operator's controls

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National foreword

This British Standard is the UK implementation of ISO 10968:2020. It supersedes BS ISO 10968:2004, which is withdrawn.

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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).

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).

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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.

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.

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Introduction

This document specifies design criteria for operator's controls on earth-moving machinery. As machines have gone through significant developments since the first edition of this document in 1995, this document covers both legacy machines and state-of-the-art solutions. This is important to take 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's 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's 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, it is the manufacturer's responsibility that minimum actuating forces are enough to prevent inadvertent activation of the operator's controls caused by machine operation (e.g. machine acceleration/deceleration, vibration).

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. It is recognized that new technologies and new technical measures will be developed as the state-of-the-art changes in order to improve the operation of earth-moving 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 — Wheeled machines — Steering requirements*

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 http://www.electropedia.org/

3.1
control
device actuated by an operator to execute a *machine response* (3.4)

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3.2
primary control
control (3.1) that is used frequently or continuously by the operator

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

a) For the *base machine* (3.5):

— steering;

— clutch or inch pedal;

— gear selection;

— speed (engine or ground speed);

— travel direction;

— brakes;

— swing of upper structure.

b) For equipment (3.6):

— swing operation;

— raising/lowering operation (e.g. loader lift arm, dozer blade or ripper, excavator boom, side boom winch, rope excavator winch);

— boom/arm extending/retracting;

— rearward/forward motion;

— boom side shift (e.g. side shift carriage of the backhoe linkage);

— boom fold/unfold;

— boom offset.

c) For *attachments* (3.7):

— 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;

— dump/curl operation.

3.3
secondary control
control (3.1) that is infrequently used by the operator but is needed for the proper functioning of the machine

EXAMPLE Control for parking brake, lighting, mode selection, quick coupler and stabilizers.

3.4
machine response
described function of the *base machine* (3.5) or *equipment* (3.6) or *attachment* (3.7) resulting from the activation of a *control* (3.1)

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
machine with a cab or canopy and operator protective structures if required, without *equipment* (3.6) or *attachments* (3.7) but possessing the necessary mountings for such equipment and attachments

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

3.6
equipment
set of components mounted onto the *base machine* (3.5) which allows an *attachment* (3.7) 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 onto the *base machine* (3.5) or *equipment* (3.6) for specific use

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

3.8
proportional control
control (3.1) that allows continuously variable or modulated *machine response* (3.4)

3.9
remote operator control
operator *control* (3.1) 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, modified — The accepted term "remote control" has been deleted.]

3.10
control actuating force
force required at the centre of the *control* (3.1) 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 (3.11) movable in one axis that controls the described function

3.13
two lever control
two *single lever controls* (3.12) that, in combination, control the described function

3.14
two-axis multifunction control
lever (3.11) movable in axes a-b + c-d that controls the described functions

Note 1 to entry: See Figure 3.

3.15
four-axis multifunction control
lever (3.11) movable in axes a-b + c-d + e-f + g-h that controls the described functions

Note 1 to entry: See Figure 3.

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3.16
button
control (3.1) that is pressed to release or activate a function

3.17
dial
control (3.1) that is rotated in order to operate a function

3.18
pedal
control (3.1) that is exclusively foot-operated

3.19
single pedal control
pedal (3.18) movable in one axis, that controls the described function

3.20
two pedal control
two *pedals* (3.18) 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.

4.2 Control locations

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

4.3.1 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.

4.3.2 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)

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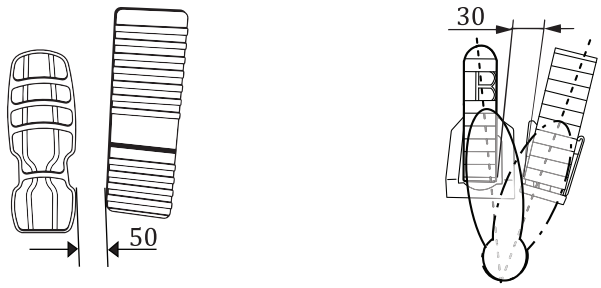
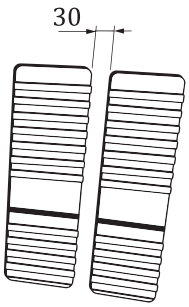
Table 1 *(continued)*

Type of control	Minimum distance between two adjacent controls
Foot-operated controls	For pedals not intended to be used simultaneously: 50 mm (clearance between two adjacent controls) for controls intended to be operated with separate feet or same foot but different heel positions (Figure 1 a). 30 mm (clearance between two adjacent controls) for controls intended to be operated with the same foot and from the same heel position. These controls shall not be parallel to each other (Figure 1 b). 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. Dimensions in millimetres  **a) Controls operated by separate feet or different heel positions** **b) Controls operated by same foot from same heel position** **Figure 1 — Distance between controls**
Foot-operated controls	For pedals intended to be used simultaneously: Maximum 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. the throttle controls on a self-propelled scraper with two separate engines) (Figure 2). The pedals may be parallel. Dimensions in millimetres  **Figure 2 — Distance between parallel pedals** Exceptions: For adjacent controls that can both be used by a single foot or used simultaneously (e.g. parallel excavator travel pedals) distances between 30 and 50 mm are also allowed.

4.3.3 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.

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4.5 Pedals

The surface of pedals shall be slip-resistant.

5 Movement of controls

5.1 General

5.1.1 The type, location and method of operation of typical primary controls shall be according to Annex A for base machine movements, according to Annex B for equipment movements, and according to 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 shall follow the same principles as given by Annex B. Primary controls for attachment not otherwise specified shall follow the same principles as given by Annex C.

5.1.2 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).

5.1.3 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.

5.1.4 All controls shall return to their neutral position when the operator releases the control, unless the control has a detent or hold position for continuous activation.

5.1.5 For foot-operated controls where the pedal is operated in two directions (treadle pedal), for example, 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.

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

5.1.7 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.

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

5.1.9 The identification symbols shall be on the controls or next to them. If space limitations dictate, a diagram, clearly visible to the operator, showing the primary controls is acceptable.

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

5.2 Multifunction controls

5.2.1 General

In the case of a multifunction 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.

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