

Safety of earth-moving machinery —

Part 20: Specification for operator's controls

ICS 53.100

Committees responsible for this British Standard

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British Coal Corporation
 Construction Plant (Hire Association)
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 Health and Safety Executive
 Institution of Civil Engineers
 Silsoe Research Institute

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National foreword

This Part of BS 6912 has been prepared by Subcommittee B/513/1. It is identical with ISO 10968:1995 *Earth-moving machinery — Operator's controls*, published by the International Organization for Standardization (ISO).

ISO 10968 was prepared by Subcommittee 2, Safety requirements and human factors, of ISO Technical Committee 127, Earth-moving machinery, with the active participation and approval of the UK.

Cross-references

Publication referred to	Corresponding British Standard
ISO 3411:1982 ^a	BS 5538:1983 <i>Specification for minimum operator space envelope for earth-moving machinery</i> (Identical)
ISO 3450:1985	BS 6824:1987 <i>Specification for performance and test of braking systems for wheeled earth-moving machinery</i> (Identical)
ISO 5010:1992	BS 6912 <i>Safety of earth-moving machinery</i> Part 10:1993 <i>Specification for steering capability of rubber tyred earth-moving machines</i> (Identical)
ISO 6165:1987	BS 6914 <i>Terminology (including definitions of dimensions and symbols) for earth-moving machinery</i> Part 1:1988 <i>Glossary of terms for basic types of earth-moving machinery</i> (Identical)
ISO 6405-1:1991	BS 6913 <i>Operation and maintenance of earth-moving machinery</i> Part 8:1992 <i>Specification for common symbols for operator controls and other displays</i> (Identical)
ISO 6405-2:1993	Part 9:1994 <i>Specification for specific symbols for machines, equipment and accessories</i> (Identical)
ISO 6682:1986	BS EN ISO 6682:1995 <i>Earth-moving machinery. Zones of comfort and reach for controls</i> (Identical)

^a Revision in preparation. It is envisaged that upon publication of the revised international standard it will be implemented as a British Standard.

The Technical Committee has reviewed the provisions of ISO 6405-2:1993/DAM 1, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This International Standard specifies the requirements for the operator's primary controls on earth-moving machinery as they relate to the ride-on operator.

The provisions for hand-, finger- or foot-operated controls are not intended to prevent usage of other types of controls, control locations or control movements. However the general requirements and principle of arrangement should be followed considering operator's safety and ergonomics.

This International Standard applies to earth-moving machinery as defined in ISO 6165. It does not cover secondary controls (see 3.2).

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

ISO 3450:1985, *Earth-moving machinery — Wheeled machines — Performance requirements and test procedure for braking systems*.

ISO 5010:1992, *Earth-moving machinery — Rubber-tyred machines — Steering requirements*.

ISO 6165:1987, *Earth-moving machinery — Basic types — Vocabulary*.

ISO 6405-1:1991, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*.

ISO 6405-2:1993, *Earth-moving machinery — Part 2: Specific symbols for machines, equipment and accessories*.

ISO 6405-2:1993/DAM 1:—, *Earth-moving machinery — Part 2: Specific symbols for machines, equipment and accessories — AMENDMENT 1¹⁾*.

ISO 6682:1986, *Earth-moving machinery — Zones of comfort and reach for controls*.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 primary control

control that is used frequently or continuously by the operator

NOTE 1 These controls are as follows:

- a) for the base machine:
 - 1) steering;
 - 2) clutch or inch pedal;
 - 3) gear selection;
 - 4) speed;
 - 5) travelling;
 - 6) brakes;
 - 7) rotary/slewing motion;
- b) for equipment:
 - 1) raising/lowering operations (e.g. loader arm, dozer equipment, excavator boom, side boom winch, rope excavator winch);
 - 2) boom extending or retracting operations;
 - 3) backward-/forward motion (e.g. backhoe-arm);
 - 4) attachment operations (e.g. bucket, shovel, clamshell, forges, dump body);
 - 5) rotary/slewing operations.

3.2 secondary control

control that is infrequently used by the operator but is needed for proper function of the machine (e.g. control for parking brake, for lighting)

3.3 active operation

motion for the primary function of the attachment (e.g. moving the cutting edges in the direction of the break-out force, closing clamshell)

4 Control location

4.1 The location of primary controls shall be in accordance with ISO 3411 and ISO 6682.

4.2 The distance between control levers, adjacent pedals, handles, knobs, the operator's body and other machine parts shall be sufficient to allow operation without unintentional actuation of adjacent controls. The overlapping of controls is permissible to provide independent and simultaneous control application.

4.3 Controls, control linkage and their power supply shall be arranged in such a manner that they cannot be damaged or moved into a dangerous position by foreseeable external forces, i.e. maximum hand or foot force or shaking (vibration) of the machine.

4.4 Hand- or finger-operated controls with control forces of up to 150 N shall have a free distance of at least 25 mm in each position to any adjacent parts.

¹⁾ To be published.

4.5 The surface of frequently used pedals shall be fitted with slip-resistant material.

5 Movement of controls

5.1 The movement of the controls in relation to their neutral position shall be in the same general direction as the movement they control unless combining of controls or customary usage dictates otherwise (e.g. driving control of machines where the operator's position is located on a slewable part of the machine, like the upperstructure of an excavator).

5.2 If a machine is equipped with an alternative driver's position, with equivalent control arrangements, both sets of controls shall operate in the same manner.

The engagement shall be either automatic or clearly identified with an acoustic or visual warning.

Crawler and skid-steer machines shall maintain the same correspondence between action on steering controls and direction of travel, whatever the position of the reversible drive.

5.3 All controls shall return to their neutral or hold position when the operator releases control of them unless the functional control of the machine or its equipment dictate otherwise, such as controls that are continuously or automatically activated, or that have a functionally related detent position.

5.4 There shall be no hazardous movement during or following start-up or stop of the power supply or engine.

5.5 If control signals are electrically transmitted, no hazardous unintended action shall be caused by electrical interference fields (see [1] and [2]).

5.6 The various controls shall be so arranged or deactivated or guarded that they cannot be activated unintentionally and in particular when the operator gets into or out of the operator's station according to the manufacturer's instruction.

5.7 The type, location and method of operation of the primary controls are described in Annex A for the base machine and in Annex B for its equipment.

5.8 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.

Graphical symbols shall be in accordance with ISO 6405-1, ISO 6405-2 and its draft Amendment (ISO 6405:1993/DAM 1).

5.9 Typical arrangements of controls are shown in Annex C.

6 Control force

The maximum forces shown in Table 1 shall not be exceeded for normal operation.

However, these forces may be exceeded on a control for an emergency. The forces in Table 1 do not apply to braking and steering systems. Maximum control forces for these systems are specified in ISO 3450 and ISO 5010 respectively. The direction of force application is referenced to the operator's position whilst operating the control.

Table 1 — Control operating forces

Control operation	Maximum operating force ^a N
Hand	
lever, forward/backward	230
lever, sideways	100
brake lever, upwards	400
Foot	
pedal	450
tread, centre-pivoted	230
Toe	
pedal	90
Fingertip	
lever or switch	20
^a Current machine designs provide lower forces. Minimum control forces are dependent on the control system, and as such are not stated.	

Annex A (normative)**Earth-moving machinery — Primary common controls for base machine**

No.	Control	Location	Operation requirements
A.1	Steering		
A.1.1	Steering-wheel	Forward of the operator	A clockwise rotation shall effect a right turn, and a counter-clockwise rotation shall effect a left turn.
A.1.2	Hand-operated: one-lever control	See 4.1	Moving lever to the left shall effect a left turn and moving lever to the right shall effect a right turn.
A.1.3	Hand-operated: two-lever control	See 4.1	Moving the left lever forward and/or the right lever rearward shall effect a right turn. Moving the left lever rearward and/or the right lever forward shall effect a left turn.
A.2	Clutch and inch pedals		
	Foot-operated	Accessible to the operator's left foot	Pushing pedal forward and/or downward shall effect disengagement.
A.3	Gear selection		
	Hand-operated	See 4.1	Shifting pattern shall be simple and clearly marked. In particular, the neutral position shall be clearly identified and easy to select.
A.4	Speed: engine and/or ground speed		
	Foot-operated	Accessible to the operator's right foot	Acceleration: Forward and/or downward motion shall increase speed. Deceleration: Forward and/or downward motion shall decrease speed.
A.5	Travelling		
A.5.1	Direction control: forward-reverse non-variable speed		
	Hand-operated	Accessible to the operator	Moving control forward/upward or to the right shall effect forward motion and moving control rearward/down or to the left shall effect rearward motion.
A.5.2	Combination ground speed and direction: continuously variable combined control		
A.5.2.1	Hand-operated	Accessible to the operator	Moving control from neutral position forward and/or upward shall effect forward motion and increasing forward speed. Moving control from neutral position rearward and/or downward shall effect rearward motion and increasing rearward speed.
A.5.2.2	Foot-operated: one-pedal control	Accessible to the operator's right foot	The pedal shall pivot under the operator's foot and shall come to rest in the neutral position. Forward and/or downward motion of the front of the pedal shall effect forward motion and increasing forward speed. Downward motion on the rear of the pedal shall effect rearward motion and increasing rearward speed.
A.5.2.3	Foot-operated: two-pedal control	Accessible to the operator's feet	Forward and/or downward motion of the right pedal shall effect forward motion and increasing forward speed. Downward motion on the left pedal shall effect rearward motion and increasing rearward speed.

No.	Control	Location	Operation requirements
A.5.3	Combination ground speed, direction and steering: continuously variable combined control		
A.5.3.1	Hand-operated: one-lever control	Accessible to the operator	Forward motion of the lever shall effect forward motion and increasing speed. Reverse motion of the lever shall effect reverse motion and increasing speed. Moving lever to the left shall effect a left turn and moving lever to the right shall effect a right turn.
A.5.3.2	Hand-operated: two-lever control	Accessible to the operator	Forward motion of both levers shall effect forward motion and increasing speed. Reverse motion of both levers shall effect reverse motion and increasing speed. Moving the left lever forward and the right lever rearward shall effect a right turn. Moving the left lever rearward and/or the right lever forward shall effect a left turn.
A.5.3.3	Foot-operated: two-pedal control	Accessible forward of the operator	The pedals shall pivot under the operator's foot and shall remain at rest in the neutral position. Downward motion of the front of both pedals shall effect forward motion and increasing speed. Downward motion of the rear of both pedals shall effect reverse motion and increasing speed. Downward motion of the front of the left pedal and downward motion of the rear of the right pedal shall effect a right turn. Downward motion of the front of the right pedal and downward motion of the rear of the left pedal shall effect a left turn.
A.6	Brakes		
A.6.1	Service brake		
A.6.1.1	Foot-operated	See 4.1	The direction of motion shall be generally forward and/or downward for engagement.
A.6.1.2	Hand-operated	See 4.1	Pull motion to apply is preferred.
A.6.2	Combination steering and brake		
A.6.2.1	Foot-operated: two-pedal control with overlapping	See 4.1	Moving the right pedal downward shall effect a right turn. Moving the left pedal downward shall effect a left turn. Moving the "overlap" pedal downward shall effect a stop.
A.6.2.2	Foot-operated: three-pedal control	See 4.1	Moving the right pedal downward shall effect a right turn. Moving the left pedal downward shall effect a left turn. Moving the centre pedal downward shall effect a stop.
A.6.3	Rotary/slewing brake		
	Foot-operated	Accessible to the operator's left foot	Direction of motion shall be downward for engagement.

No.	Control	Location	Operation requirements
A.7	Rotary/slewing motion		
	Hand-operated: turnable lever control	Accessible to the operator	Clockwise movement shall effect clockwise rotation.
A.7.1	Upperstructure slewing/rotating		
A.7.1.1	Hand-operated single lever control	Accessible to the operator's left hand	Moving lever forward shall effect clockwise rotation.
A.7.1.2	Hand-operated; multipurpose lever control	Accessible to the operator's left hand	Moving lever to the right shall effect clockwise rotation.

Annex B (normative)

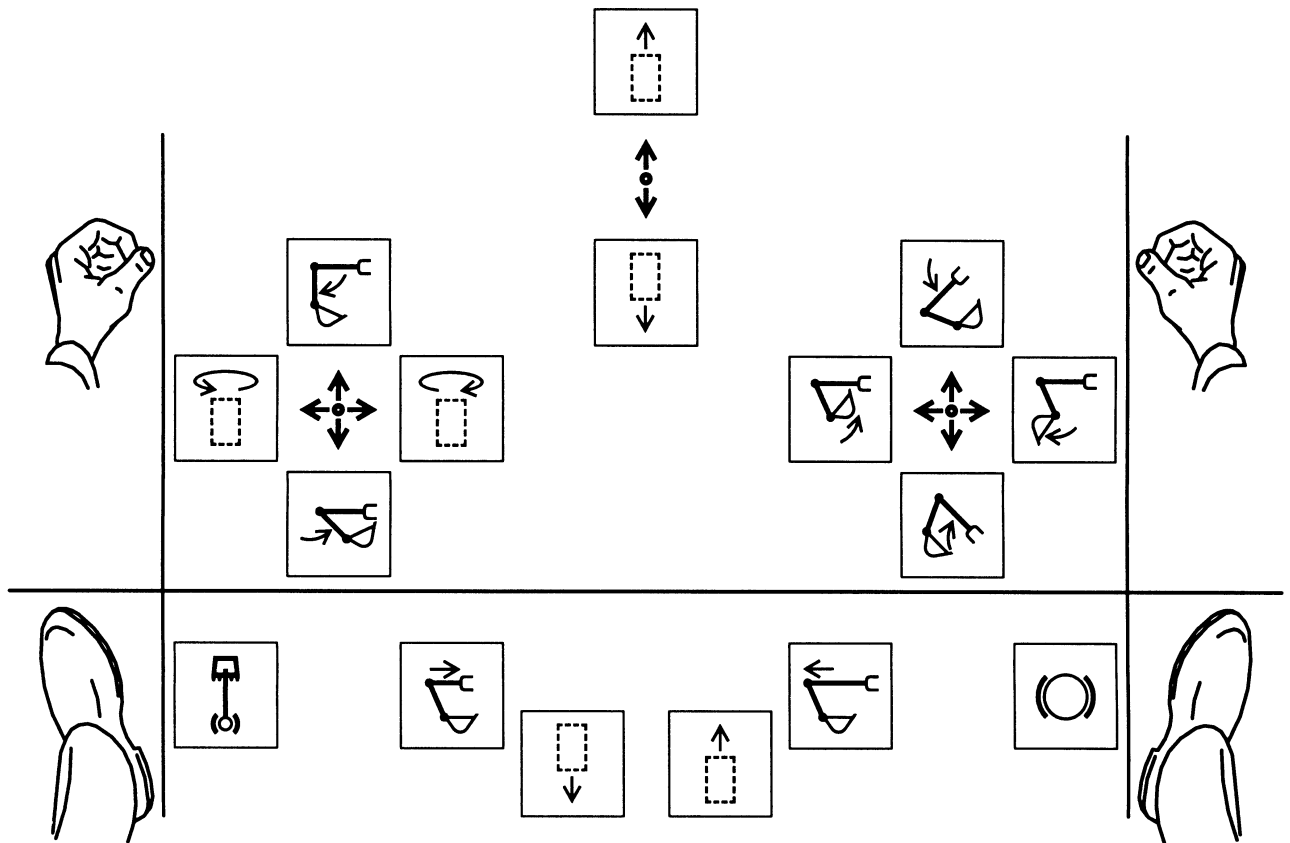
Earth-moving machinery — Primary equipment control

No.	Control	Location	Operation requirements ^a
B.1	Raising/lowering		
B.1.1	Hand-operated	Accessible to the operator's right hand, for left-hand dump body operation	Moving lever rearward shall raise and moving lever forward shall lower the equipment.
B.1.2	Foot-operated: one-pedal control	Accessible to the operator's foot	The pedal shall pivot under the operator's foot and shall remain at rest in the neutral position. Moving the rear of the pedal downward shall raise the equipment. Moving the front of the pedal downward shall lower the equipment.
B.1.3	Foot-operated: two-pedal control	Accessible to the operator's feet	Moving the right pedal downward shall raise the equipment. Moving the left pedal downward shall lower the equipment.
B.2	Extension/retraction		
B.2.1	Hand-operated	Accessible to the operator's left hand	Moving lever forward shall extend the equipment. Moving lever rearward shall retract the equipment.
B.2.2	Foot-operated: one-pedal control	Accessible to the operator's right foot	The pedal shall pivot under the operator's foot and shall remain at rest in the neutral position. Moving the front of the pedal downward shall extend the equipment. Moving the rear of the pedal downward shall retract the equipment.
B.2.3	Foot-operated: two-pedal control	Accessible to the operator's feet	Moving the right pedal downward shall extend the equipment. Moving the left pedal downward shall retract the equipment.
B.3	Rear/forward motion		
B.3.1	Hand-operated	Accessible to the operator's left hand	Moving lever rearward shall effect rearward motion.

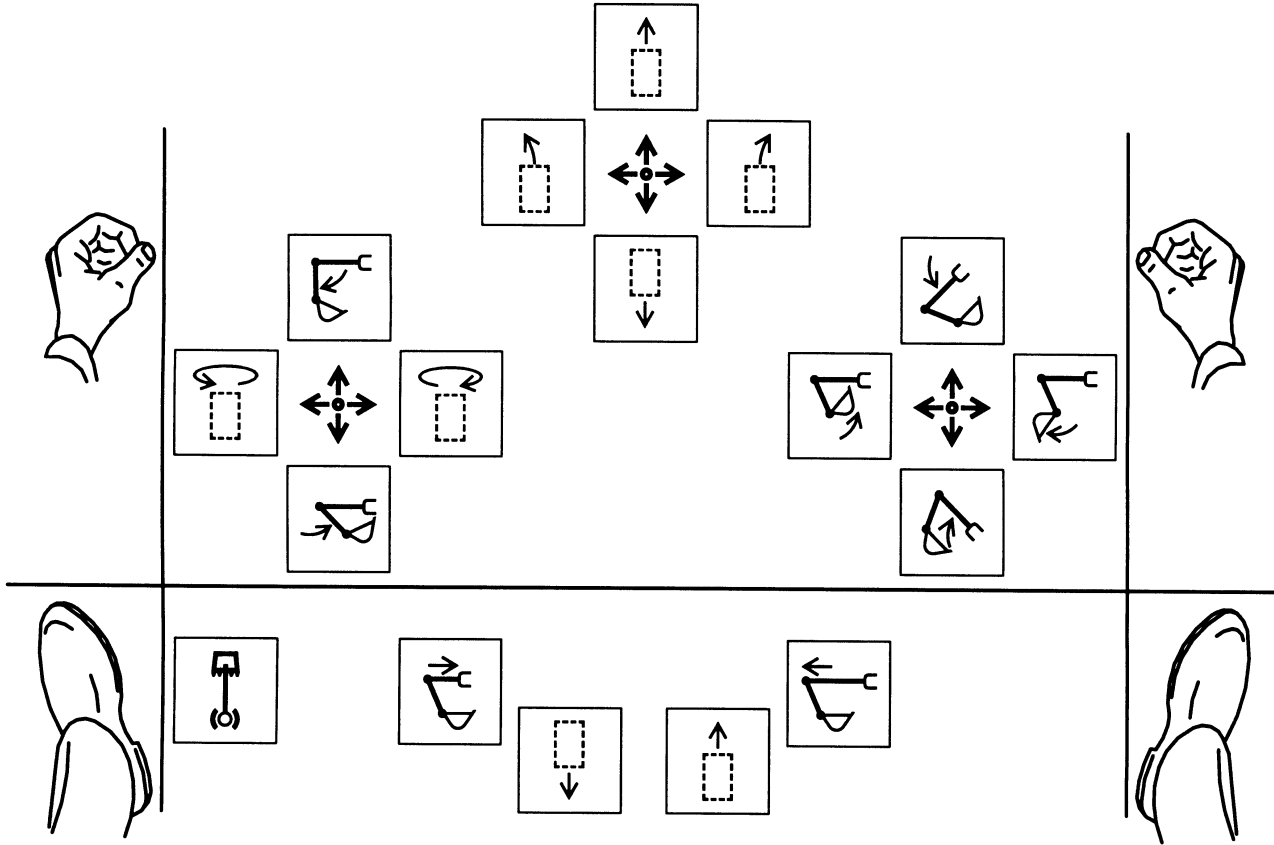
No.	Control	Location	Operation requirements ^a
B.3.2	Foot-operated: one-pedal control	Accessible to the operator's left foot	The pedal shall pivot under the operator's foot and shall remain at rest in the neutral position. Moving the front of the pedal downward shall effect forward motion. Moving the rear of the pedal downward shall effect rearward motion.
B.3.3	Foot-operated: two-pedal control	Accessible to the operator's feet	Moving the right pedal downward shall effect forward motion. Moving the left pedal downward shall effect rearward motion.
B.4	Active attachment operation (see 3.3)		
B.4.1	Hand-operated: single lever control	Accessible to the operator's right hand	Moving lever rearward shall effect active operation.
B.4.2	Hand-operated: multipurpose lever control	Accessible to the operator's right hand	Moving lever to the left shall effect active operation.
B.4.3	Foot-operated: one-pedal control	Accessible to the operator's right foot	The pedal shall pivot under the operator's foot and shall remain at rest in the neutral position. Moving the rear of the pedal downward shall effect active operation.
B.4.4	Foot-operated: two-pedal control	Accessible to the operator's right foot	Moving the right pedal downward shall effect active operation.
B.5	Rotary/slewing operation		
B.5.1	Hand-operated: single lever control	Accessible to the operator's left hand	Moving lever forward or to the right shall effect clockwise rotation.
B.5.2	Hand-operated: multipurpose lever control	Accessible to the operator's left hand	Moving lever to the right shall effect clockwise rotation.
B.5.3	Hand-operated: turnable lever control	Accessible to the operator	Clockwise movement shall effect clockwise rotation.
B.5.4	Foot-operated: one-pedal control	Accessible to the operator's left foot	The pedal shall pivot under the operator's foot and shall remain at rest in the neutral position. Downward motion of the front of the pedal shall cause a clockwise rotation. Downward motion to the rearward of the pedal shall cause a counter-clockwise rotation.
B.5.5	Foot-operated: two-pedal control	Accessible to the operator's left foot	Forward and/or downward motion of the right pedal shall cause a clockwise rotation. Forward and/or downward motion of the left pedal shall cause a counter-clockwise rotation.
^a On many types of earth-moving machines, the direction of motion of the equipment depends on the height of the equipment above ground and the position of the attachment. Therefore a middle height and position are used in defining the operations.			

Annex C (informative) Typical arrangements of controls

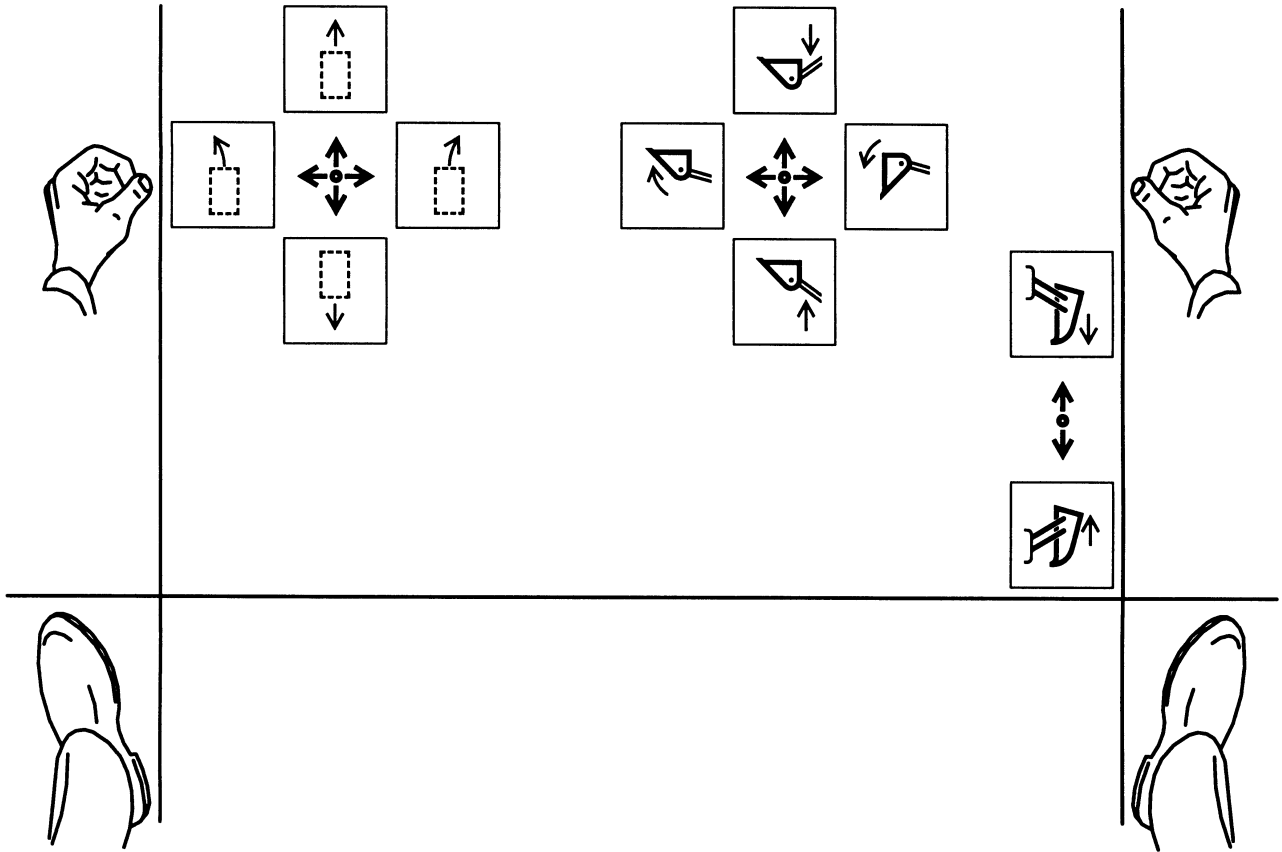
C.1 Wheeled excavators



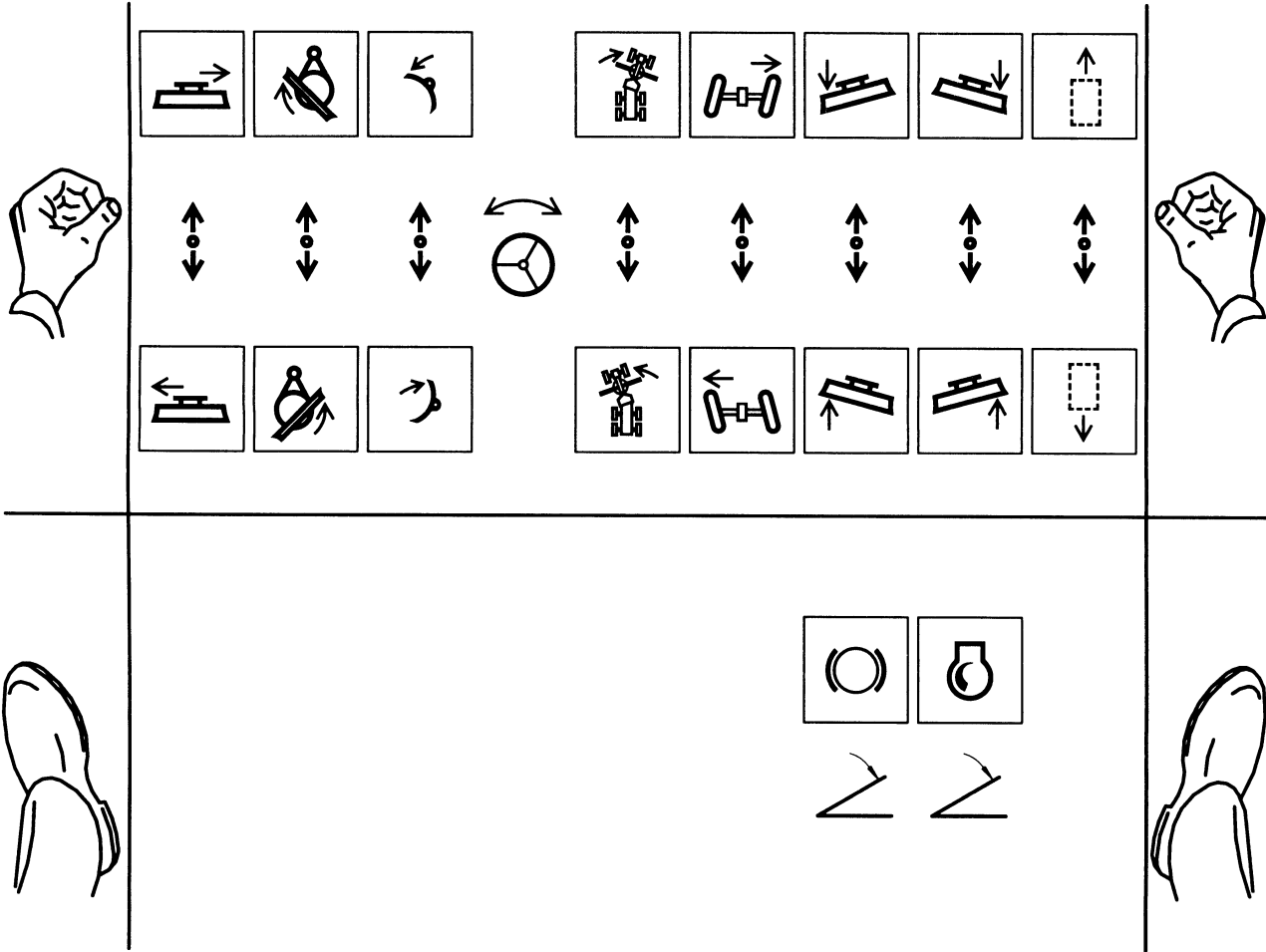
C.2 Crawler machines



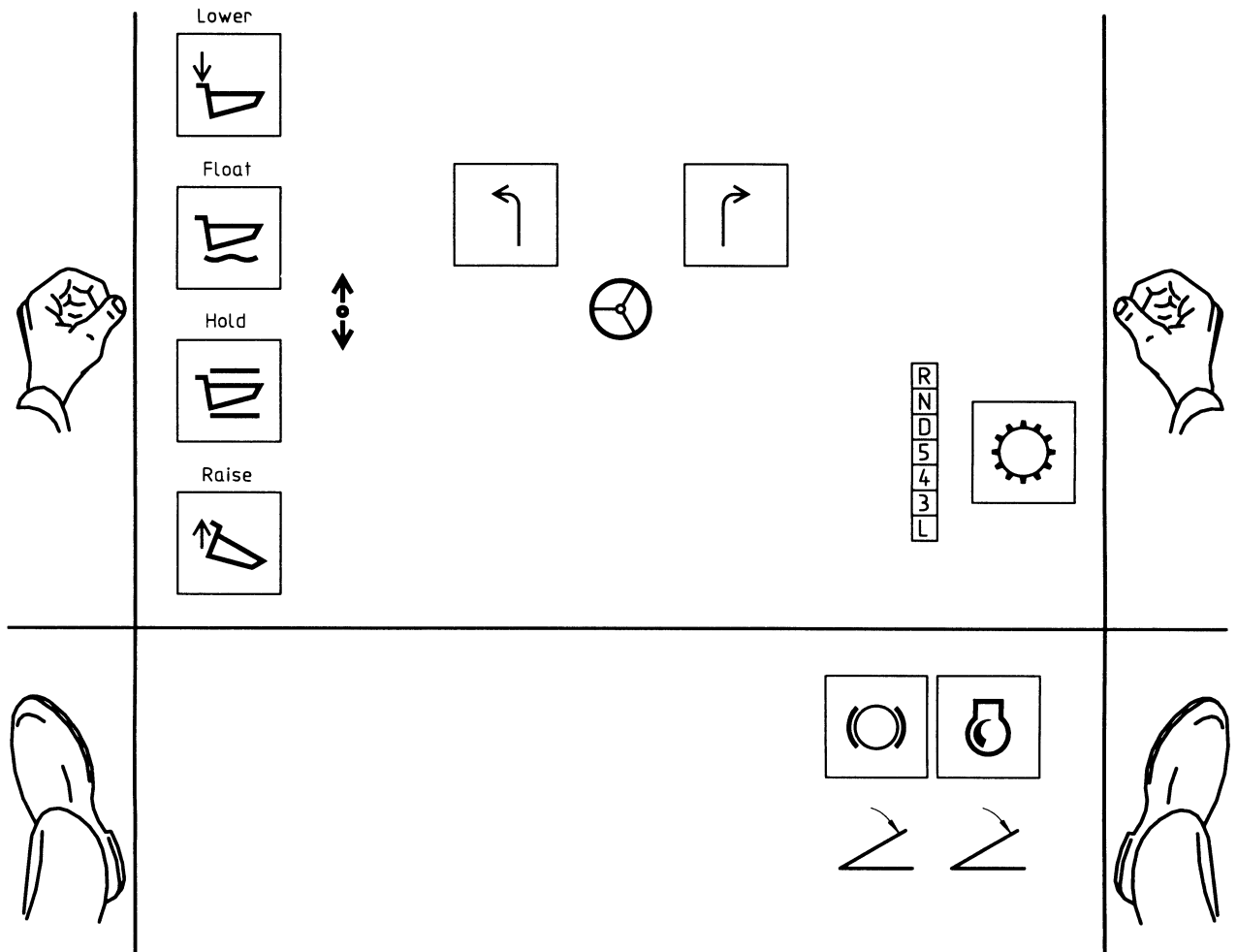
C.3 Loaders



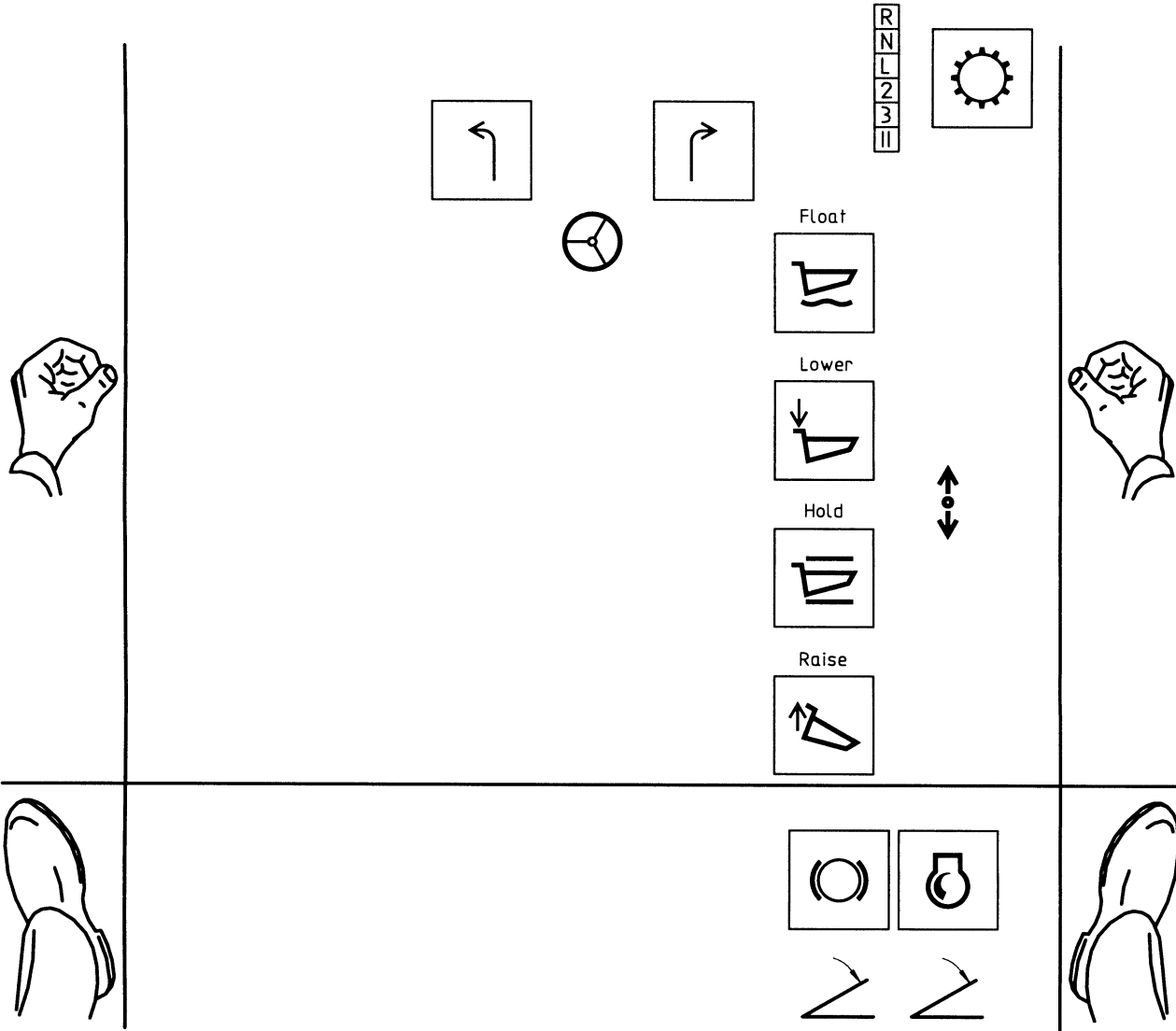
C.4 Graders



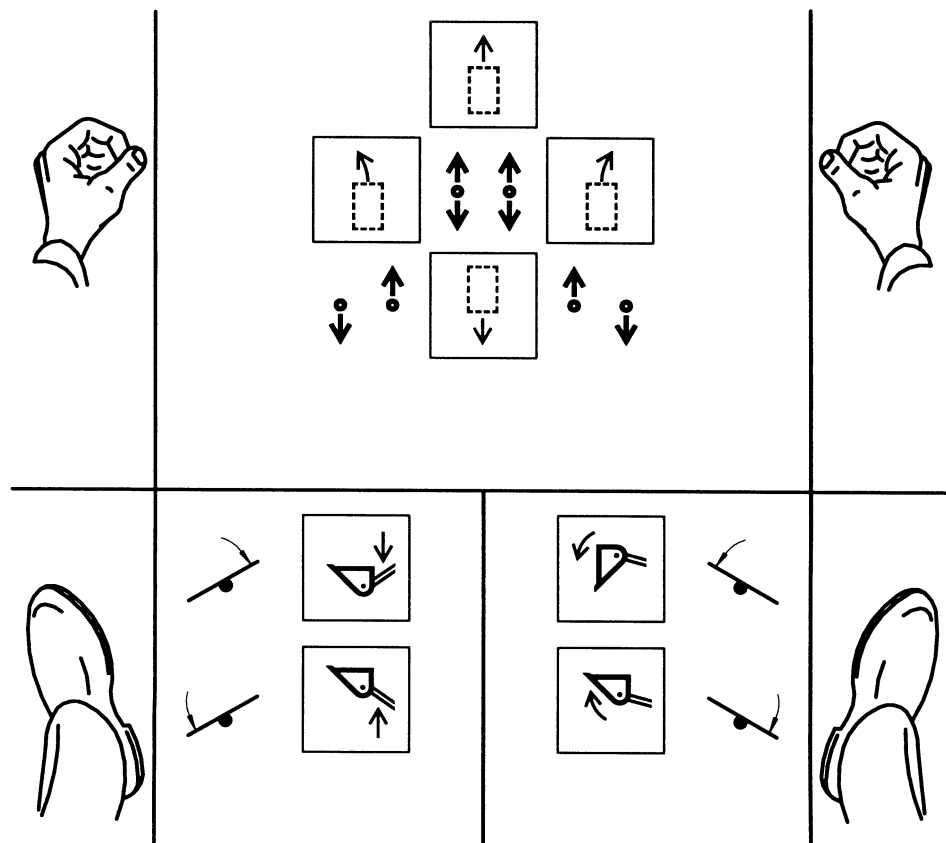
C.5 Dumpers with cab on left side



C.6 Dumpers with cab in centre or on right side



C.7 Skid-steer loaders



Annex D (informative)

Bibliography

[1] ISO 7637-0:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 0: Definitions and general.*

[2] ISO 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supplied voltage — Electrical transient conduction along supply lines only.*

List of references

See national foreword.

**BS 6912-20:
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ISO 10968:
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