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Mobile elevating work platforms — Operator's controls — Actuation, displacement, location and method of operation

Plates-formes élévatrices mobiles de personnel — Commandes de l'opérateur — Actionnement, déplacements, dispositions et modes de fonctionnement

Reference number
ISO 21455:2020(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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).

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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 214, *Elevating work platforms*.

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.

This corrected version of ISO 21455:2020 corrects the value for the width of joystick grip hand in Table 3.

Introduction

This document has been developed to provide methods of operation and requirements for operator's controls on mobile elevating work platforms. These provisions have been derived from experience, current practice, human factors literature and existing standards.

Mobile elevating work platforms — Operator's controls — Actuation, displacement, location and method of operation

1 Scope

This document specifies the performance requirements, location, marking and method of operation related to operator's controls on mobile elevating work platforms (hereafter referred to as MEWPs) and takes into account operator safety and ergonomics.

It applies to all controls used by an operator and includes provisions for finger, thumb, hand, and foot operated controls.

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 16368, *Mobile elevating work platforms — Design, calculations, safety requirements and test methods*

ISO 20381, *Mobile elevating work platforms — Symbols for operator controls and other displays*

ISO 7000, *Graphical symbols for use on equipment — Registered symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16368 and the following 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 affect a response from the MEWP

3.1.1
primary control
control (3.1) used by the operator for travelling or movement of the extending structure

3.1.2
secondary control
any *control* (3.1) of the MEWP other than a *primary control* (3.1.1)

3.1.3
multi-functional control
control (3.1) which is capable of providing two or more functions simultaneously

Note 1 to entry: A multi-functional control can also be a *multi-purpose control* (3.1.4).

EXAMPLE A combination of steering and travel, or a combination of slewing and boom elevation.

3.1.4
multi-purpose control
control which, depending on the mode selected, provides separate and distinct functions using the same actuating movement

EXAMPLE A multi-purpose control can also be a *multi-functional control* (3.1.3).

3.1.5
mode select control
control (3.1) used to select the operating mode of a *multi-purpose control* (3.1.4)

EXAMPLE Travel mode, extending structure mode.

3.1.6
travel support control
control (3.1) used during travel to warn of movements or adapt the MEWP travel configuration

EXAMPLE Horn, steer mode, differential lock, torque.

3.1.7
bi-directional foot control
rocker-type foot operated pedal *control* (3.1) capable of being operated in two directions

3.2
control actuating force
force exerted at the centre of the manufacturer's specified *control* (3.1) contact surface in order to activate a *control* (3.1) function

3.3
inadvertent activation
any *control* (3.1) activation other than that intentionally initiated by the operator

3.4
operation
performance of functions of a MEWP within the scope of its specifications and in accordance with the manufacturer's instructions, work rules, and applicable governmental regulations

[SOURCE: ISO 18893:2014, 3.7]

3.5
primary working configuration
configuration of a MEWP, when in the elevated position identified by the manufacturer for *control* (3.1) orientation

3.6
primary travel configuration
configuration of a MEWP, when in the travel position identified by the manufacturer for *control* (3.1) orientation

4 Control actuating forces and torques

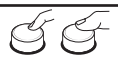
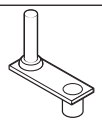
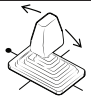
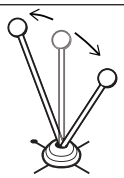
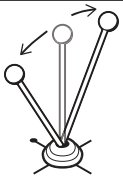
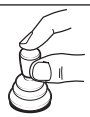
4.1 The control actuating forces and torques shall be in accordance with the values given in Table 1.

4.2 The minimum strength of each control shall be sufficient to withstand at least five times its maximum actuation force without sustaining permanent damage (for example, deformation, fracture) or having its primary function impeded.

In addition, hand-operated joysticks shall be capable of withstanding a minimum force of 350 N without sustaining permanent damage (for example, deformation, fracture) or having its primary function impeded.

NOTE This additional strength requirement does not apply to additional control mechanisms as described in 7.2.2.1.

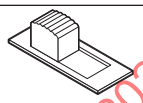
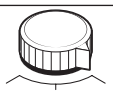
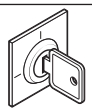
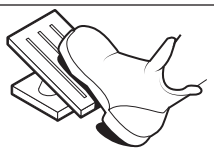
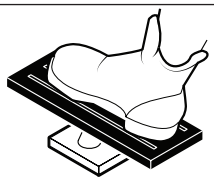
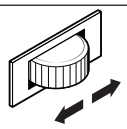
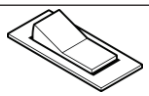
Table 1 — Control actuating forces and torques

Control type	Operator interaction	Force N		Torque N mm		Example illustration
		Min.	Max.	Min.	Max.	
Push button	One finger	2,8	11	N/A	N/A	
	Thumb	2,8	23	N/A	N/A	
Toggle switch	Thumb and finger	2	20	N/A	N/A	
Crank	Wrist and finger	9[a]	22[a]	N/A	N/A	
	Arm movement	22[a]	45[a]	N/A	N/A	
Lever (forward/back)	Thumb and finger	7	50	N/A	N/A	
	Hand	9	135	N/A	N/A	
	2 hands	9	220	N/A	N/A	
Lever (left/right)	Thumb and finger	7	50	N/A	N/A	
	Hand	9	90	N/A	N/A	
	2 hands	9	135	N/A	N/A	
Joystick	Thumb and finger	2	22	N/A	N/A	
	Thumb	2	22	N/A	N/A	
	Hand	2	118	N/A	N/A	

[a] Represents tangential force.

N/A Non-applicable.

Table 1 *(continued)*

Control type	Operator interaction	Force N		Torque N mm		Example Illustration
		Min.	Max.	Min.	Max.	
Slide switch – Small (≤9 mm × 10 mm × 10 mm) (*H* × *W* × *L*)	Finger and thumb	2,8	4,5	N/A	N/A	
Slide switch – Large (>9 mm × 10 mm × 10 mm) (*H* × *W* × *L*)	Finger and thumb	2,8	11	N/A	N/A	
Knob ≤25 mm diameter	Finger and thumb	N/A	N/A	14	32	
Knob >25 mm diameter	Finger and thumb	N/A	N/A	14	42	
Rotary selector	Fingers, hand	N/A	N/A	115	680	
Key switch	Thumb and finger	N/A	N/A	115	680	
Foot control	Foot not resting on control	18	90	N/A	N/A	
	Foot resting on control	45	90	N/A	N/A	
	Bi-directional	45	135	N/A	N/A	
Thumbwheel – Discrete	Finger, thumb	1,7[a]	5,6[a]	N/A	N/A	
Thumbwheel – Continuous adjustment	Finger, thumb	1,7[a]	3,3[a]	N/A	N/A	
Rocker switch	Finger, thumb	2,8	11	N/A	N/A	
Push pull control	Two fingers	2	18	N/A	N/A	
	Hand	2	45	N/A	N/A	
Legend/ membrane - Snap action contact	Finger	1,5	8	N/A	N/A	

[a] Represents tangential force.

N/A Non-applicable.

Table 1 *(continued)*

Control type	Operator interaction	Force N		Torque N mm		Example Illustration
		Min.	Max.	Min.	Max.	
Legend/ membrane - Membrane contact	Finger	2	8	N/A	N/A	
[a] Represents tangential force. N/A Non-applicable.						

5 Control locations

5.1 General

Access to controls shall be in accordance with ISO 16368:2010, 4.7.3.

5.2 Work platform controls

5.2.1 The control panel is positioned in the normal location and orientation as defined by the manufacturer.

5.2.2 Primary controls, travel support controls and emergency stop controls operated by the hand, finger or thumb shall be located at a height between 845 mm and 1 250 mm. Measurements shall be taken from the work platform floor to the point of application of the control actuating force with controls in the neutral position (see Figure 1).

5.2.3 Hand operated controls shall be located at a maximum of 500 mm from the edge of the control panel closest to the operator (see Figure 1).

5.2.4 For MEWPs operated in countries where National or other MEWP regulations allow a minimum guardrail height of 0,9 m, the controls described in 5.2.1 are permitted to be located at a height 155 mm below the top of the guardrails.

Dimensions in millimetres

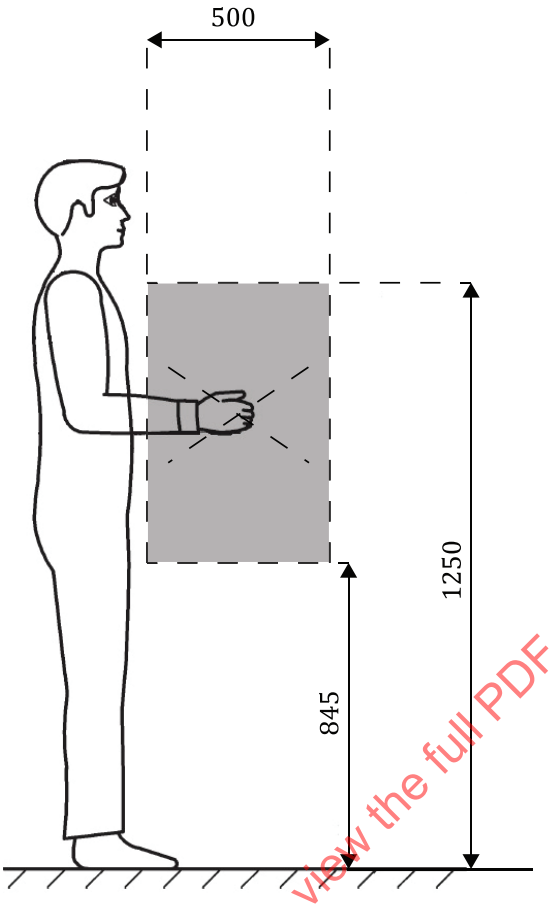


Figure 1 — Dimensions for typical standing operator relative to the operator workstation

5.2.5 Foot controls shall be positioned to minimize the operator having to twist and/or turn to reach the controls.

5.3 Base or ground level controls

Base or ground level controls, including emergency overriding system controls, shall be located in accordance with ISO 16368:2010, 4.7.3 and 4.7.8.

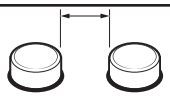
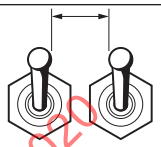
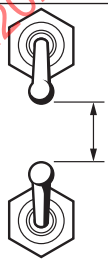
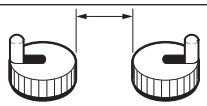
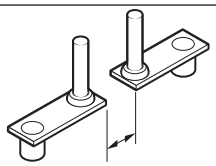
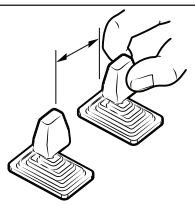
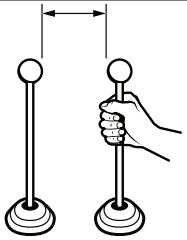
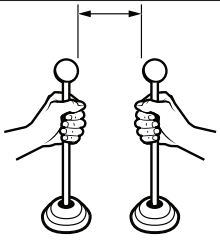
5.4 Minimum separation distance

5.4.1 When hand-operated controls need to be operated simultaneously, their separation distance shall not be greater than 760 mm.

5.4.2 The minimum separation distance between controls (without dividers or shrouds) shall be in accordance with Table 2.

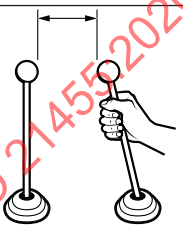
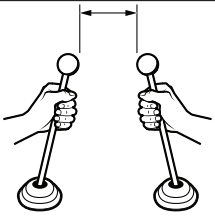
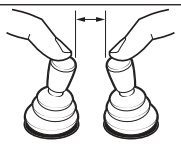
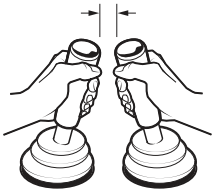
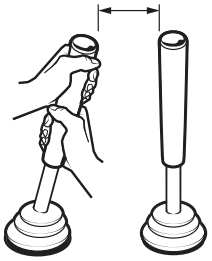
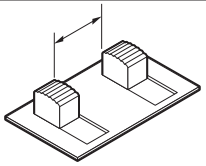
NOTE The values in Table 2 take into consideration an operator wearing gloves and are based on standard cotton flame resistant anti-flash gloves [in other words, Navy flash gloves (as defined in MIL-G-2874E)].

Table 2 — Minimum separation distance for controls on consoles or similar surfaces

Control Type	Type of use	Minimum separation distance mm	Example Illustration
Push-buttons	One finger	25	
Toggle switches	One finger	32	
	Vertical array – (Upper row toggle down, lower row toggle up)	38	
Cranks	Wrist and finger	50	
	Arm movement	75	
Levers (forward/ backward)	Thumb and finger	20	
	One hand	50	
	Two hands – simultaneously	75	

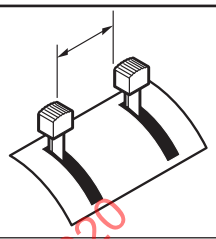
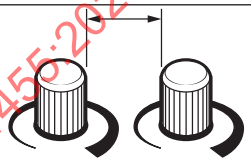
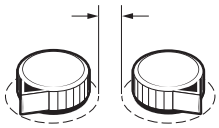
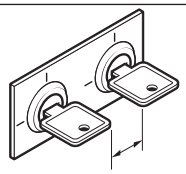
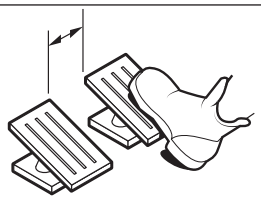
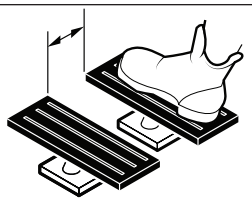
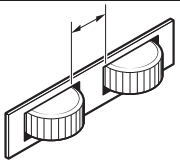
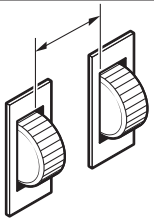
[a] For MEWPs meeting the requirements of ISO 16653-3.

Table 2 *(continued)*

Control Type	Type of use	Minimum separation distance mm	Example Illustration
Levers (left/right)	Thumb and finger	20	
	One hand	50	
	Two hands – simultaneously	75	
Joysticks	Finger	25	
	One hand – each (adjacent)	50	
	Two hands	75	
Slide switches	One finger	19	

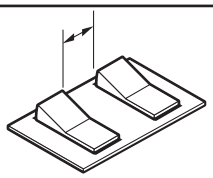
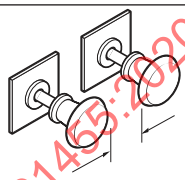
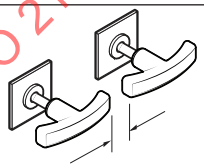
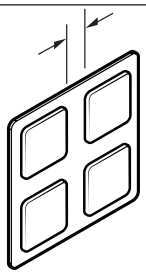
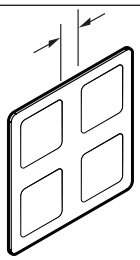
[a] For MEWPs meeting the requirements of ISO 16653-3.

Table 2 *(continued)*

Control Type	Type of use	Minimum separation distance mm	Example Illustration
Slide levers (banked)	Any	25	
Knobs (turnable)	One hand	25	
	Two hands – simultaneously	90	
Rotary selectors	One hand	25	
	Two hands – simultaneously	90	
Key switches	One hand	40	
Foot controls	One foot	100	
	One foot (bi-directional)	100	
	One foot (bi-directional – simultaneous operation)[a]	20	
Thumbwheels (parallel rotational axis)	Finger	70	
Thumbwheels (co-linear rotational axis)	Finger	38	

[a] For MEWPs meeting the requirements of ISO 16653-3.

Table 2 *(continued)*

Control Type	Type of use	Minimum separation distance mm	Example Illustration
Rocker switches	One finger	25	
Push-pull controls	Two fingers	38	
	Hand	38	
Legend/ membrane – Snap action contacts	One finger	3	
Legend/ membrane – Membrane contacts	One finger	3	
[a] For MEWPs meeting the requirements of ISO 16653-3.			

5.5 Dividers or shrouds

5.5.1 Minimum separation distances may be reduced if a divider or shroud is used, provided their height is no less than the height of the adjacent controls in their neutral position.

5.5.2 Dividers shall have no sharp edges.

5.5.3 Dividers shall be designed to allow visual access to controls, labels or displays.

6 Sizing of controls

Sizing of controls shall be in accordance with Table 3.

Table 3 — Sizing for commonly used controls

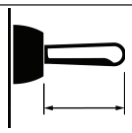
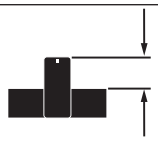
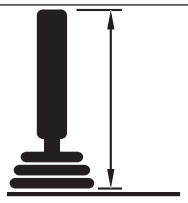
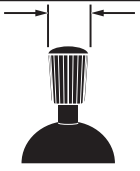
Control type – Specification	Operator interaction	Minimum mm	Maximum mm	Example Illustration
Pushbutton switch – Diameter	Finger	6	32	
Pushbutton switch – Diameter	Thumb	19	60	
Toggle switch tip – Diameter	Finger	3	25	
Toggle switch tip – Length	Finger	10	50	
Rotary selector switch – Length	Thumb/finger	15	100	
Rotary selector switch – Width	Thumb/finger	N/A	25	
Rotary selector switch – Depth	Thumb/finger	16	75	
Joystick grip – Width	Hand	25	54	
Joystick shaft – Length	Hand	40	180	
Joystick grip – Depth	Thumb/finger	6,5	40	
N/A Non-applicable.				

Table 3 *(continued)*

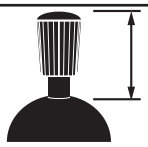
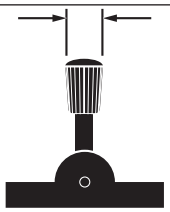
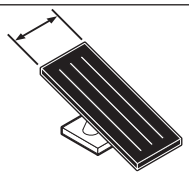
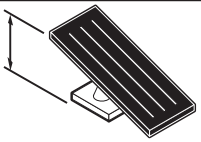
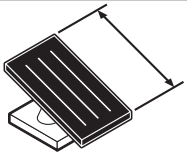
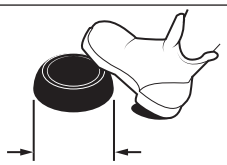
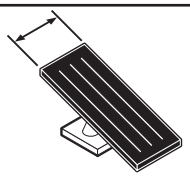
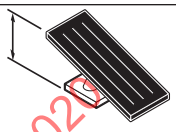
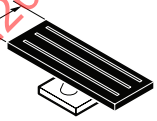
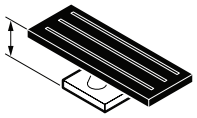
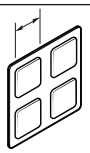
Control type – Specification	Operator interaction	Minimum mm	Maximum mm	Example Illustration
Joystick – Length	Thumb/finger	40	150	
Joystick – Width	Thumb	15	22	
Knob – Diameter	Finger	6	76	
Knob – Depth	Finger	13	25	
Lever – Diameter	Thumb/finger	6,5	38	
Lever – Diameter	Hand	38	75	
Foot control – Width	Foot	50	N/A	
Foot control – Height	Foot	25	65	
Foot control – Length	Foot	90	N/A	
Foot control – Diameter	Foot	13	N/A	
N/A Non-applicable.				

Table 3 *(continued)*

Control type – Specification	Operator interaction	Minimum mm	Maximum mm	Example Illustration
Foot control – Continuous activation – Width	Foot	110	N/A	
Foot control – Continuous activation – Height	Foot	N/A	60	
Foot control – Bi-directional – Width	Foot	110	N/A	
Foot control – Bi-directional – Height	Foot	N/A	60	
Membrane (all)	Finger	6	32	
N/A Non-applicable.				

7 Movement of controls

7.1 General

7.1.1 The movement of the controls, when in the primary working configuration or primary travel configuration, should be in the same general direction as the MEWP response.

7.1.2 Unless otherwise specified in this document:

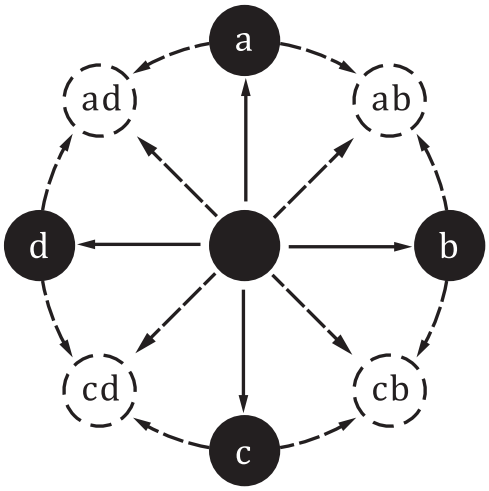
— movement of a control forward, clockwise, to the right, up or pressing a control should turn equipment on or cause the controlled parameter value to increase;

— movement of a control backward, anticlockwise, to the left, down or releasing a control should turn equipment off or cause the controlled parameter value to decrease.

7.2 Multi-functional joystick controls

7.2.1 Combined movements

The combined movement of operational functions, for example, diagonal movement forward and left or diagonal movement forward and right, diagonal movement rearward (backward) and left or diagonal movement rearward (backward) and right is permitted (see Figure 2).



Key

a forward movement
b movement to the right
c rearward (backward) movement
d movement to the left
ab combination of movement a and b
ad combination of movement a and d
cb combination of movement c and b
cd combination of movement c and d

NOTE Described movement only relates to movement of multifunctional joystick controls, not the resultant movement of the MEWP.

Figure 2 — Resulting movements of a multi-function control

7.2.2 Additional controls located on a multi-functional control

7.2.2.1 Additional control mechanisms, such as knobs or switches, may be located on a multi-functional control.

7.2.2.2 The control device for the additional control mechanisms and the response shall be indicated by a control mechanism label or visual indicator.

7.3 Multi-purpose controls

7.3.1 The selected mode of a multi-purpose control shall be visually indicated.

7.3.2 The selected mode of the multi-purpose control shall deactivate after a period of function inactivity of no more than 10 s.

7.4 Mode selection for multi-purpose controls

For extending structure and travel multi-purpose controls, selection of the extending structure shall be to the left or up, and selection of travel to the right or down.

7.5 Activation and operation

7.5.1 General

7.5.1.1 Controls shall be designed such that movements of the MEWP only take place while the controls are being actuated, except for controlled decelerations of any structure in motion. Any controls related to movement, when released, shall automatically return to the neutral position. Travel controls of vehicle-mounted MEWPs do not need to satisfy this requirement.

7.5.1.2 All controls affecting motion shall be designed to protect against inadvertent activation. A separate function enable control meets this requirement.

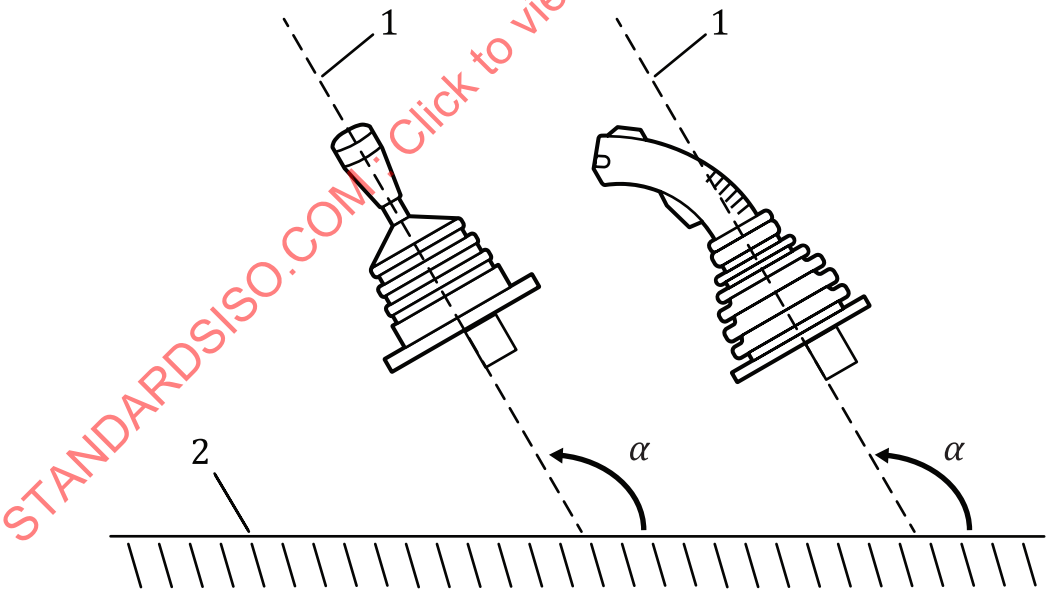
7.5.1.3 The requirement for a function enable control (see 7.6) does not apply to foot-controlled orchard MEWPs manufactured according to ISO 16653-3:2011, 4.5.1.

7.5.2 Control orientation and operation — Work platform controls

7.5.2.1 The neutral position of controls for raising and lowering the extending structure and controls for travel shall have their centrelines oriented to the work platform floor as shown in Figures 3, 4 and 5.

7.5.2.1.1 Multi-purpose controls that combine raising and lowering functions with travel functions, shall meet the requirements of both Figure 4 and Figure 5.

7.5.2.1.2 Multi-function controls that combine raising and lowering functions with travel functions, shall meet the requirements of both Figure 4 and Figure 5.



Key

1 work platform control centreline in the neutral position

2 work platform floor

α angle between the work platform control centreline in the neutral position and the work platform floor

Figure 3 — Work platform control orientation relative to work platform floor

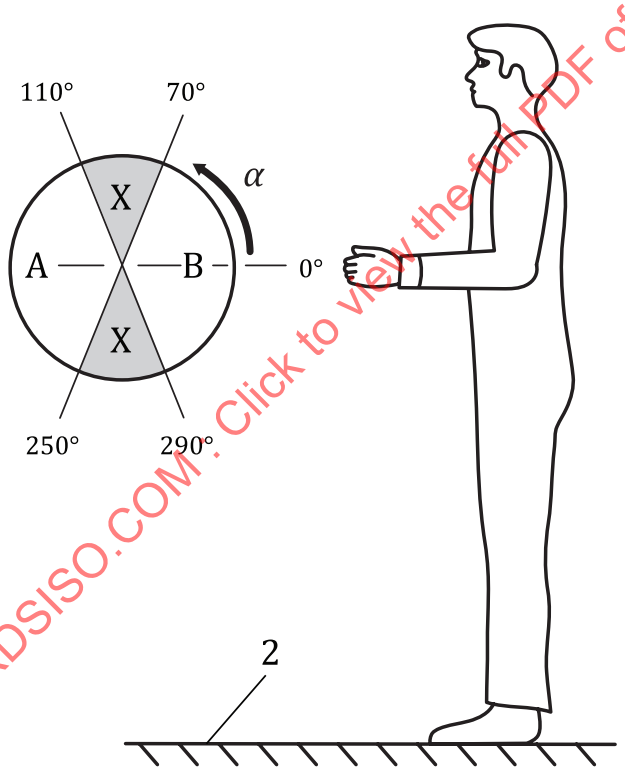
7.5.2.2 The operational characteristics for controls located at the work platform shall be in accordance with Table 4. Control types referenced in Table 4 with no distinguishable direction of movement (for example, push-button and membrane controls) are exempt from the requirements of this clause.

7.5.3 Operational characteristics for lever-operated stacked or banked controls located at the work platform

The operational characteristics in Table 4 shall be followed for a group of lever-operated controls that are stacked or banked and located at the work platform with the exception of slew or rotate extending structure controls. To slew or rotate extending structure to the right of the operator the direction of control movement shall be upward. To slew or rotate extending structure to the left of the operator the direction of control movement shall be downward.

7.5.4 Work platform control orientation zones for raising and lowering of the extending structure

Electro-mechanical work platform controls for raising and lowering the extending structure, shall be oriented, based on the work platform control centreline in relation to the work platform floor, as shown in Zone A or Zone B of Figure 4.



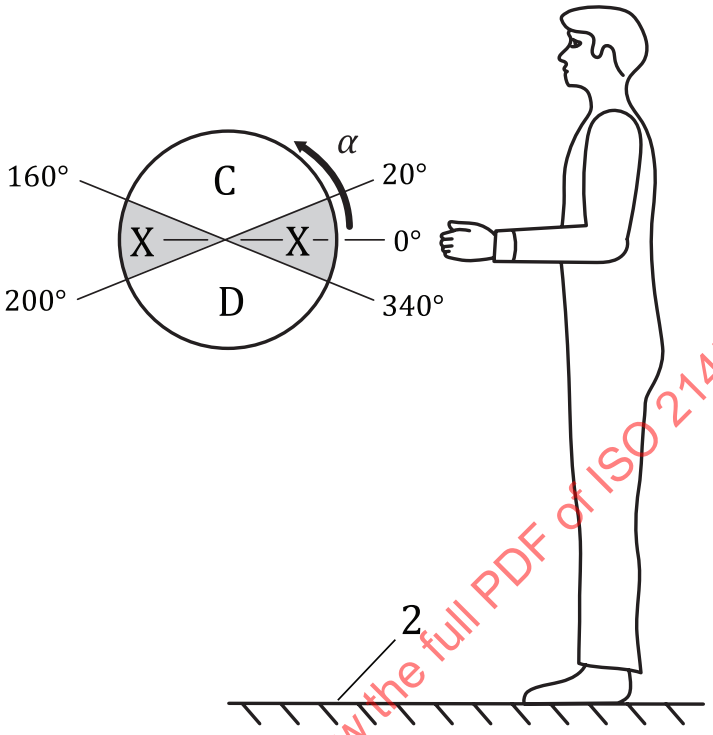
Key

2 work platform floor
A work platform control orientation angle range, Zone A
B work platform control orientation angle range, Zone B
X no work platform control orienting allowed in this zone
α angle between the work platform control centreline in the neutral position and the work platform floor

Figure 4 — Work platform control orientation zones for raising and lowering of the extending structure

7.5.5 Work platform control orientation zones for travelling

Electro-mechanical work platform controls for travel shall be oriented, based on the work platform control centreline in relation to the work platform floor, as shown in Zone C or Zone D of Figure 5.

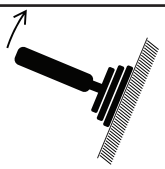
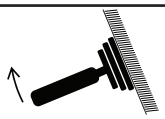
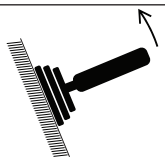
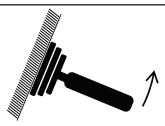
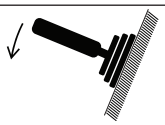
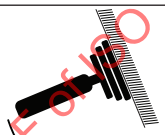
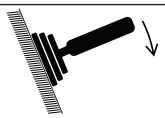
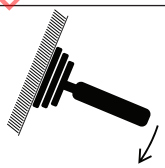
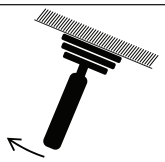
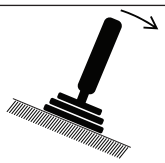
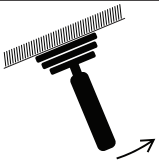


Key

2 work platform floor
C work platform control orientation angle range, Zone C
D work platform control orientation angle range, Zone D
X no work platform control orienting allowed in this zone
α angle between the work platform control centreline in the neutral position and the work platform floor

Figure 5 — Work platform control orientation zones for travelling

Table 4 — Operational characteristics of controls located at the work platform

Operation	Reference	Orientation of the centre-line of control when in neutral position	Example Illustration		Direction of movement
Raise extending structure	Figure 4	Zone A			Move up
		Zone B			
Lower extending structure	Figure 4	Zone A			Move down
		Zone B			
Drive forward	Figure 5	Zone C			Move forward
		Zone D			
Drive backward	Figure 5	Zone C			Move backward
		Zone D			

[a] For lever-operated controls that are stacked or banked and located at the work platform, see 7.5.3.

N/A Non-applicable.