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

*Plates-formes élévatrices mobiles de personnel — Calculs de
conception, exigences de sécurité et méthodes d'essai*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 16368 was prepared by Technical Committee ISO/TC 214, *Elevating work platforms*.

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Introduction

The object of this International Standard is to define rules for safeguarding persons and objects against the risk of accidents associated with the operation of mobile elevating work platforms (MEWPs).

This International Standard does not repeat all the general technical rules applicable to every electrical, mechanical or structural component.

The safety requirements of this International Standard have been drawn up on the basis that MEWPs are periodically maintained according to manufacturers' instructions, working conditions, frequency of use and national regulations.

It is assumed the MEWPs are checked for function daily before start of work and are not put into operation unless all required control and safety devices are available and in working order.

If a MEWP is seldom used, the checks may be made before start of work.

Annex A explains the choice of Beaufort Scale 6 as maximum wind speed.

Where for clarity an example of a safety measure is given in the text, this is not intended as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved.

As no satisfactory explanation could be found for the dynamic factors used for stability calculations in previous national standards, the results of the tests carried out by the European Committee for Standardization (CEN), former TC 98/WG1, to determine a suitable factor and stability calculation method for MEWPs have been adopted. The test method is described in Annex B as a guide for manufacturers wishing to use higher or lower operating speeds and to take advantage of developments in control systems.

Similarly, to avoid the unexplained inconsistencies in coefficients of utilization for wire ropes found in other standards for lifting devices, appropriate extracts of the widely accepted German standard DIN 15020 (all parts) have been included in 5.5.2 and Annex C, with a worked example in Annex D.

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

1 Scope

This International Standard specifies technical safety requirements and measures for all types and sizes of mobile elevating work platforms (MEWPs) intended to move persons to working positions.

This International Standard is applicable to the structural design calculations and stability criteria, construction, safety examinations and security tests before MEWPs are first put into service. It identifies the hazards arising from the use of MEWPs and describes methods for the elimination or reduction of these hazards.

It does not cover the hazards arising from

- operation by radio and other wireless controls,
- use in potentially explosive atmospheres,
- electromagnetic incompatibility,
- work on live electrical systems (see IEC 61057),
- use of compressed gases for load-bearing components.

This International Standard is not applicable to

- a) permanently installed personnel-lifting appliances serving defined levels (see EN 81-1 and EN 81-2);
- b) fire-fighting and fire rescue appliances (see EN 1777);
- c) unguided work cages suspended from lifting appliances (see EN 1808);
- d) elevating operator position on rail-dependent storage and retrieval equipment (EN 528);
- e) tail lifts (see EN 1756-1 and prEN 1756-2);
- f) mast-climbing work platforms (see ISO 16369);
- g) fairground equipment;
- h) lifting tables with a lifting height of less than 2 m (see EN 1570);
- i) builders' hoists for persons and materials (see EN 12159);
- j) aircraft ground-support equipment (see EN 1915-1 and EN 1915-2);
- k) digger derricks (see ANSI A10.31);
- l) elevating operator positions on industrial trucks (see EN 1726-2);

- m) under-bridge inspection and maintenance devices (see ANSI A92.8);
- n) stock-picking or order-picking type equipment.

2 Normative references

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

ISO 2408:1985, *Steel wire ropes for general purposes — Characteristics*

ISO 3864 (all parts), *Graphical symbols — Safety colours and safety signs*

ISO 4302, *Cranes — Wind load assessment*

ISO 4305, *Mobile cranes — Determination of stability*

ISO 4309, *Cranes — Wire ropes — Care, maintenance (including installation), inspection*¹⁾

ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*

ISO 13850, *Safety of machinery — Emergency stop — Principles for design*

ISO 13854, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 18893, *Mobile elevating work platforms — Safety requirements, inspection, maintenance and operation*¹⁾

ISO 20381 *Mobile elevating work platforms — Symbols for operator controls and other displays*¹⁾

IEC 60204-1:2000, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC 60707, *Flammability of solid non-metallic materials when exposed to flame sources — List of test methods*

IEC 60947-5-1:2000, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 61057:1991, *Aerial devices with insulating boom used for live working*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18893 and the following apply.

3.1

access position

normal position which provides access to and from the work platform

NOTE The access, stowed (3.30), lowered travel (3.12) and transport (3.32) positions can be identical.

1) To be published.

3.2**chain-drive system**

system that comprises one or more chain(s) running on chain sprockets and on or over chain pulleys as well as any associated chain sprockets, chain pulleys and compensating pulleys

3.3**chassis**

base of the MEWP

See Figure 1.

NOTE The chassis may be pulled, pushed, self-propelled, etc.

3.4**critical component**

load-supporting element which supports or stabilizes the work platform or the extending structure

3.5**elevated travel position**

configuration of the MEWP for travel on a work site outside of the lowered travel position

3.6**extending structure**

structure which is connected to the chassis and supports the work platform and allows movement of the work platform to its required position

See Figure 1.

NOTE It may, for example, be a single or a telescoping or an articulating boom or ladder, or a scissor mechanism or any combination of them, and may or may not slew on the base.

3.7**finite element analysis model
FEA model**

computerized method of idealizing a real model for the purposes of performing structural analysis

3.8**indoor use**

use of a MEWP in areas shielded from wind so there is no wind force acting on the MEWP

3.9**load cycle**

cycle starting from a position, carrying out work and returning to the same position

3.10**load-sensing system**

system of monitoring the vertical load and vertical forces on the work platform

NOTE The system includes the measuring device(s), the method of mounting the measuring devices and the signal processing system.

3.11**lowering, noun**

all operations, other than travelling, to move the work platform to a lower level

See Figure 1.

3.12**lowered travel position**

configuration of the MEWP for travel on a work site where the work platform height is 3 m or less

NOTE The access (3.1), stowed (3.30), lowered travel and transport (3.32) positions can be identical.

3.13

manufacturer

person or entity with overall responsibility for the design, specification, procurement, fabrication, assembly and testing of a ready-for-use MEWP

3.14 MEWP group classification

3.14.1

group A

MEWPs whose vertical projection of the centre of gravity of the load is always inside the tipping lines

3.14.2

group B

MEWPs whose vertical projection of the centre of gravity of the load may be outside the tipping lines

3.15 MEWP types

3.15.1

type 1 MEWP

MEWP for which travelling is only allowed with the MEWP in its stowed position

3.15.2

type 2 MEWP

MEWP for which travelling with work platform in elevated travel position is controlled from a point on the chassis

3.15.3

type 3 MEWP

MEWP for which travelling with work platform in elevated travel position is controlled from a point on the work platform

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NOTE Types 2 and 3 can be combined.

3.16

mobile elevating work platform

MEWP

machine (device) that is intended to displace persons, tools and material to working positions and consists of at least a work platform with controls, an extending structure and a chassis

3.17

moment-sensing system

system of monitoring the moment acting about the tipping line tending to overturn the MEWP

NOTE The system includes the measuring device(s), the method of mounting the measuring devices and the signal processing system.

3.18

off-slab

surface that is not necessarily levelled, paved, or of concrete or an equivalent material, but does not include uncompacted soil

3.19

outdoor use

use of a MEWP in an environment which may be exposed to wind

3.20

paved slab surface

substantially level surface of asphalt, concrete or equivalent

3.21**pedestrian-controlled MEWP**

MEWP whose controls for powered travel can be operated by a person walking close to the MEWP

3.22**rail-mounted MEWP**

MEWP whose travel is guided by rails

3.23**raising**, noun

any operation, other than travelling, which moves the work platform to a higher level

See Figure 1.

3.24**rated load**

load for which the MEWP has been designed for normal operation and is composed of persons, tools and material acting vertically on the work platform

NOTE A MEWP can have more than one rated load.

3.25**rotation**

circular movement of the work platform about a vertical axis

See Figure 1.

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3.26**secondary work platform**

platform attached to the work platform (3.39) or the extending structure, and able to be moved separately

3.27**self-propelled MEWP**

MEWP whose travelling controls are located on the work platform

3.28**slewing**, noun

circular movement of the extending structure about a vertical axis

See Figure 1.

3.29**stabilizer**

any device or system used to stabilize MEWPs by supporting and/or levelling the complete MEWP or the extending structure

See Figure 1.

EXAMPLES Outriggers, jacks, suspension-locking devices, extending axles.

3.30**stowed position**

configuration of the MEWP as defined by the manufacturer, in which the extending structure is lowered and retracted and stabilizers are retracted

NOTE The access (3.1), stowed, lowered travel (3.12) and transport (3.30) positions can be identical.

3.31
totally manually operated

MEWP whose movement is powered only by manual effort

3.32
transport position

position of the work platform in which the MEWP is delivered to the work site

NOTE The access (3.1), stowed (3.30), lowered travel (3.12) and transport positions can be identical.

3.33
transporting

delivery of the MEWP to or from the work site

3.34
travelling

any movement of the chassis except transporting

See Figure 1.

3.35
type test

test on a representative model of a new design or one incorporating significant changes to an existing design, carried out by or on behalf of the manufacturer or his authorized representative

3.36
vehicle-mounted MEWP

MEWP whose travelling controls are located within the cab of the vehicle

3.37
wire rope drive system

system that comprises one or more wire rope(s) running on rope drums and on or over rope pulleys, as well as any associated rope drums, rope pulleys and compensating pulleys

3.38
working envelope

space in which the work platform is designed to work within the specified loads and forces, under normal operation conditions

NOTE MEWPS can have more than one working envelope.

3.39
work platform

movable component of the MEWP, other than the chassis, intended for carrying personnel (with or without material)

EXAMPLES Cages, buckets and baskets.

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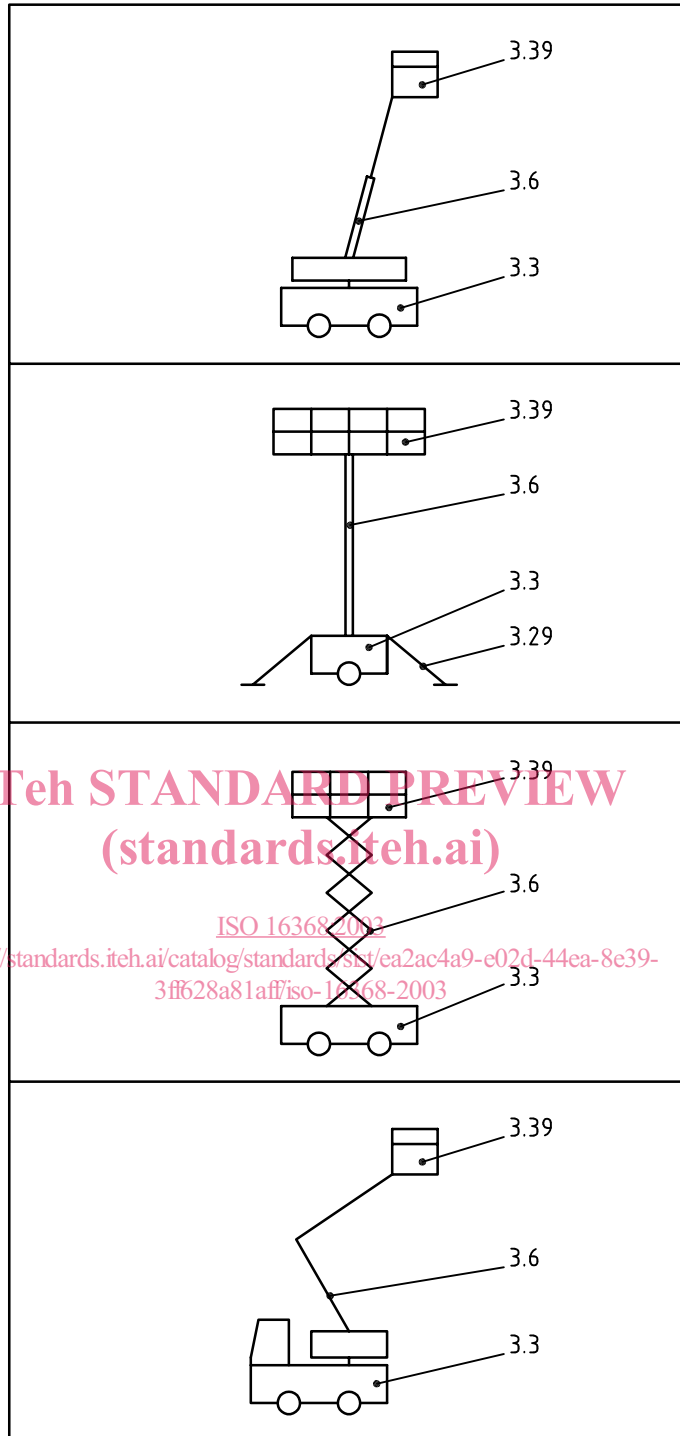


Figure 1 — Illustration of some definitions (continued)

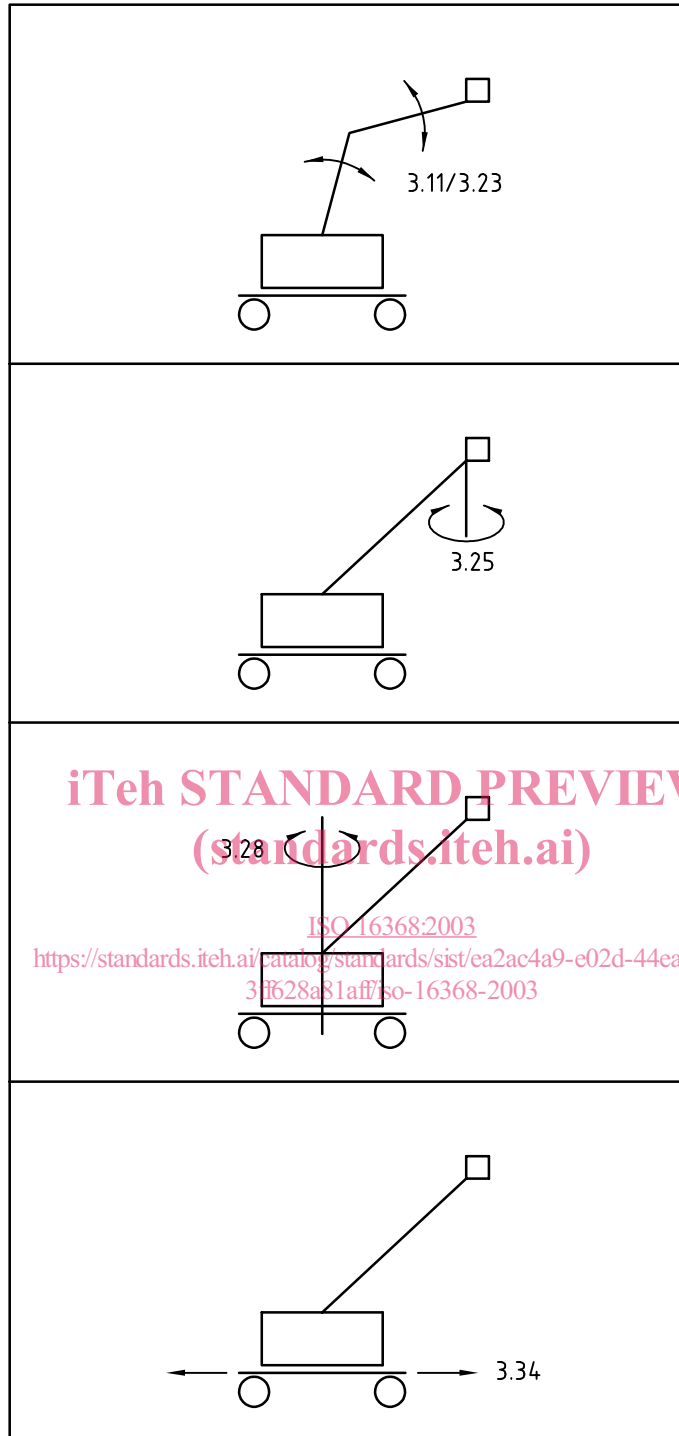


Figure 1 — Illustration of some definitions (continued)

4 List of hazards

Hazards have been identified by the risk assessment procedure and are listed in Table 1.

A hazard which is not significant and for which, therefore, no relevant clause is given in this International Standard is designated as NS (not significant).

Table 1 — List of hazards (continued)

Hazards		Relevant clauses in this International Standard
1	Mechanical hazards	
1.1	crushing hazard	5.2.4, 5.3.4, 5.3.5, 5.3.21, 5.4.4, 5.6.9, 5.7.1, 7.3.13
1.2	shearing hazard	5.4.4, 5.7.1, 7.3.13
1.3	cutting or severing hazard	NS
1.4	entanglement hazard	5.3.18, 7.3.13
1.5	drawing-in or trapping hazard	5.3.18, 7.3.13
1.6	impact hazard	5.3.5, 5.3.22, F.2.1 h)
1.7	stabbing or puncture hazard	NS
1.8	friction or abrasion hazard	F.2.5 e)
1.9	high-pressure fluid injection hazard	5.9.1, 5.9.2, 5.9.3, 5.9.4, 5.9.5, 5.9.10
1.10	ejection of parts	NS
1.11	loss of stability (of machinery and machine parts)	5.2, 5.3.2, 5.3.6, 5.3.7, 5.3.9, 5.3.10
1.12	slip, trip and fall hazards	5.6.2, 5.6.3, 5.6.4, 5.6.5, 5.6.6, 5.6.7, 7.3.13
2	Electrical hazards caused, for example, by	
2.1	electrical contact (direct or indirect)	5.8, F.2.1 g)
2.2	electrostatic phenomena	NS
2.3	thermal radiation	NS
2.4	external influences on electrical equipment	5.8.1
3	Thermal hazards resulting, for example, in	
3.1	burns and scalds by possible contact of persons with flames or explosions and also with radiation from heat sources	5.3.19
3.2	health-damaging effects from hot or cold work environment	5.3.19
4	Hazards generated by noise resulting, for example, in	
4.1	hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness, etc.)	NS
4.2	interference with speech communication, acoustic signals, etc.	NS
5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)	
		F.2.1 l)
6	Hazards generated by radiation, especially by	
6.1	electrical arcs	F.2.1 g)
6.2	lasers	NS
6.3	ionizing radiation sources	NS
6.4	machines using high-frequency electromagnetic fields	5.8.1
7	Hazards generated by materials and substances processed, used or exhausted by machinery, for example	
7.1	hazards resulting from contact with or inhalation of harmful fluids, gases, mists, dusts and fumes	5.3.19