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Vehicle lifts

bsi.

National foreword

This British Standard is the UK implementation of EN 1493:2022. It supersedes BS EN 1493:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MHE/12/3, Lifting Platforms - Vehicle lifting devices.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Vehicle lifts

Élévateurs de véhicules

Fahrzeug-Hebebühnen

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Contents

Page

European foreword

This document (EN 1493:2022) has been prepared by Technical Committee CEN/TC 98 “Lifting platforms”, the secretariat of which, is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2023, and conflicting national standards shall be withdrawn at the latest by May 2023.

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

This document supersedes EN 1493:2010.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association.

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Introduction

This document is a type C standard as stated in EN ISO 12100:2010.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered, are both indicated in the scope of this document. In addition, machinery should comply as appropriate with EN ISO 12100:2010 for hazards which are not covered by this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

The object of this document is to define rules for safeguarding persons against the risk of accidents associated with the operation of vehicle lifts.

While devising this document it was assumed that only authorized persons operate or use the vehicle lifts and that the working area is sufficiently lit.

The requirement concerning loading control is not deemed pertinent to this document in so far as:

— experience and the state of the art suggests that failing to observe this requirement has not historically given rise to unsafe situations;

— such devices which would give protection against overall and local overloading are not currently available in forms which cover all eventualities;

— the weight and weight distribution is freely available for the type of vehicles to be lifted and as such it is the responsibility of the user to prevent an unsafe situation arising;

— vehicle lifts are generally designed to suit the maximum weight of vehicle to which it would reasonably be subjected, hence the normal duty of a lift is substantially lower than the maximum.

1 Scope

This document is applicable to stationary and mobile vehicle lifts, which are not intended to lift persons but which are designed to raise vehicles totally, for the purpose of examining and working on or under the vehicles whilst in a raised position. The vehicle lift may consist of one or more lifting units.

Power supply to the vehicle lift by internal combustion engines is not considered.

The floor or ground supporting the vehicle lift in use is assumed to be horizontal.

This document does not exclude a person from entering a lifted vehicle on wheel supporting lifts, e.g. for special works or for periodical technical inspection, and vehicle lifts for rail-bound vehicles.

This document does not contain requirements for hazards which may arise on vehicle lifts where the carrying device can be tilted.

NOTE Noise does not play a role in vehicle lifts in the majority of cases and is therefore not considered in this document.

This document does not apply to:

— vehicle lifts movable when loaded;

— equipment for power driven parking of motor vehicles (see EN 14010:2003+A1:2009).

This document is applicable to vehicle lifts which are manufactured six months after the date of its publication as a European Standard.

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.

EN 13557:2003+A2:2008, *Cranes - Controls and control stations*

EN 60204-1:2018, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2016, modified)*

EN 60204-32:2008, *Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*

EN 60529:1991[1], *Degrees of protection provided by enclosures (IP Code)*

EN 60947-5-1:2017[2], *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices*

EN ISO 4413:2010, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413:2010)*

EN ISO 4414:2010, *Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010)*

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[1] As impacted by EN 60529:1991/A1:2000 and EN 60529:1991/A2:2013.
[2] As impacted by EN 60947-5-1:2017/AC:2020-05.

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2015, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13849-2:2012, *Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012)*

EN ISO 13850:2015, *Safety of machinery - Emergency stop function - Principles for design (ISO 13850:2015)*

ISO 4301-1:2016, *Cranes - Classification - Part 1: General*

ISO 16625:2013, *Cranes and hoists - Selection of wire ropes, drums and sheaves*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1 General

3.1.1
vehicle lift
lifting device with guided load carrying device for lifting land based means of transportation such as cars, motorcycles, lorries, buses, trams, rail vehicles, industrial trucks and similar, and which is designed to allow working on or under the raised vehicle

Note 1 to entry: The guidance of the load carrying device is given by the supporting structure.

Note 2 to entry: The following types of vehicle lift are examples of those covered by this definition: single and multi-column lifts, single and multi-cylinder lifts, mobile column lifts, scissor and parallelogram lifts, short stroke lifts, which support vehicle wheels, chassis or other designated lifting points (see Annex C).

3.1.2
normative vehicle
theoretical vehicle representative of the normal vehicles on which a lift is intended to operate, used as reference vehicle for structural calculations of the lift itself (see 4.7.4.2, 4.7.4.3)

3.1.3
normal vehicle
land based mean of transport such as cars, motorcycles, lorries, buses, trams, trucks and similar commonly on the road

3.1.4
special vehicle
vehicle that does not fall within the *normal vehicle* types and for which the Normative Vehicle is no longer representative (i.e.: fork-lifts, dumpers, snowcats, rail bound vehicles, mobile cranes, ...)

3.1.5
wheel track
WT
distance between the centre lines of the wheels on one axle or between centre lines of wheel pairs on twin wheel axles

3.1.6
wheelbase
distance between the centres of wheels of front and rear axle or from the centre of the wheels on the front axle to a point mid-way between axle pairs on twin axle vehicles

3.1.7
rated load
maximum load that a lift has been designed to carry referring to the normative vehicle or to special vehicles mentioned in 4.7.4.4

3.1.8
lifting capacity
maximum load that a single independent lifting unit has been designed to carry when part of a multiple lifting unit lift

3.1.9
lifting height
distance between the floor where the user is standing and the vehicle's pickup points

3.1.10
hazardous area
area under the load carrying device and under the lifted vehicle

Note 1 to entry: The hazardous area is part of the hazard zone according to EN ISO 12100:2010, 3.11.

3.1.11
operator
competent and authorized person to operate the lift and work on the vehicle

3.1.12
bystander
person other than the operator near the vehicle lift

3.1.13
initial position
lower limit position of the carrying device

3.1.14
unauthorised use
use by a person who has not received permission to operate the lift and instruction on its safe operation

3.1.15
periodical test investigation
PTI
periodic roadworthiness tests for motor vehicles and their trailers in accordance with current legislation

3.2 Lift parts

3.2.1
drive system
components and systems for lifting and lowering movements, including power source, controls and lifting elements

Note 1 to entry: Examples are:

— in electrohydraulic lifts: Electrohydraulic unit, cylinders, ropes, electric controls;

— in electromechanical lifts: Electric motor + transmission (pulley, gear box, ...), lifting screws, electric controls.

3.2.2
lifting unit
lifting device in general made up of a load carrying device, a supporting structure and its drive system

Note 1 to entry: A lifting unit may share parts of its drive system with other lifting units.

Note 2 to entry: Examples of lifting units are one column of a two column lift (see Figure C.2), one unit of a double-scissor lift (see Figure C.3).

3.2.3
independent lifting unit
lifting unit not sharing any part of or all of the drive system with other lifting units

Note 1 to entry: Example of an independent lifting unit is a single column of a mobile column lift.

3.2.4
supporting structure
part(s) of the vehicle lift which offer guidance to the load carrying device, but which do not move when the load is raised/lowered

EXAMPLE The posts on a two/four post lift.

3.2.5
load carrying device
part(s) of the vehicle lift which support the load either by direct contact with the vehicle or through contact with pick-up plates and/or pads

Note 1 to entry: The load carrying device is the part of the structure of the lift which is moving when the load is raised/lowered.

EXAMPLE Platforms, carrying arms or other mechanical devices designed to raise and support a vehicle by designated lifting points.

3.2.6
lifting element
medium through which the force is transmitted from the power source to the load carrying device

Note 1 to entry: Lifting elements include hydraulic and pneumatic cylinders, lead screw and nut systems as well as any flexible connections such as steel wire ropes and chains but excluding the ropes/chains having the sole scope of synchronising different lifting units.

3.2.7
mechanical lifting element
lifting element constructed from engineering materials and which may be reasonably subjected to wear

Note 1 to entry: Mechanical lifting elements are e.g. ropes, chains, carrying nuts and gears. Hydraulic and pneumatic cylinders do not fall under this definition.

3.2.8
carrying arm
load carrying device attached at one end, directly or indirectly to the lifting element and supporting the load at its other end

Note 1 to entry: Carrying arms are as an example used on two column lifts.

3.2.9
platform
horizontal surface or structure, part of the load carrying device, designed to drive on it with the vehicle when entering/leaving the vehicle lift

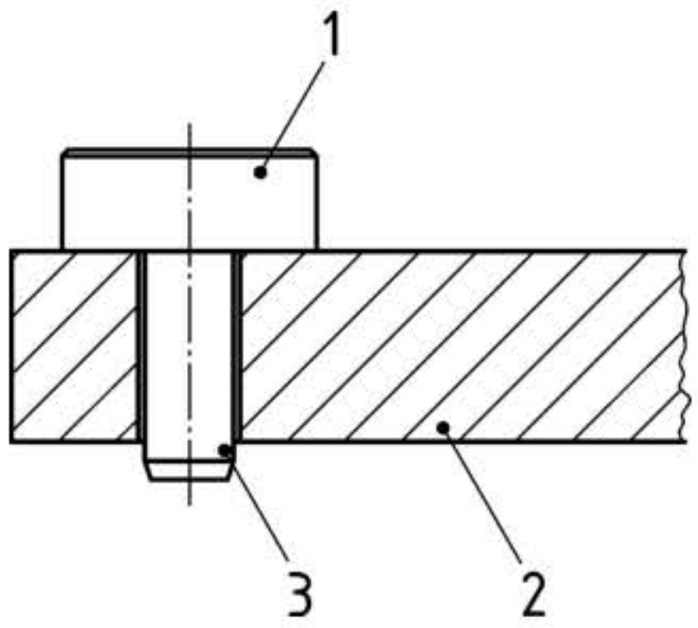
Note 1 to entry: E.g. tracks in scissor lifts.

3.2.10
pick-up plate
part of the load carrying device, e.g. on two column lifts with carrying arms, which has direct contact to the vehicle and which has an assigned position on the load carrying device

Note 1 to entry: See Figure 1.

3.2.11
pick-up pad
vehicle supporting pad which has direct contact with the vehicle but which does not have an assigned position, e.g. pads used on wheel free systems with platforms

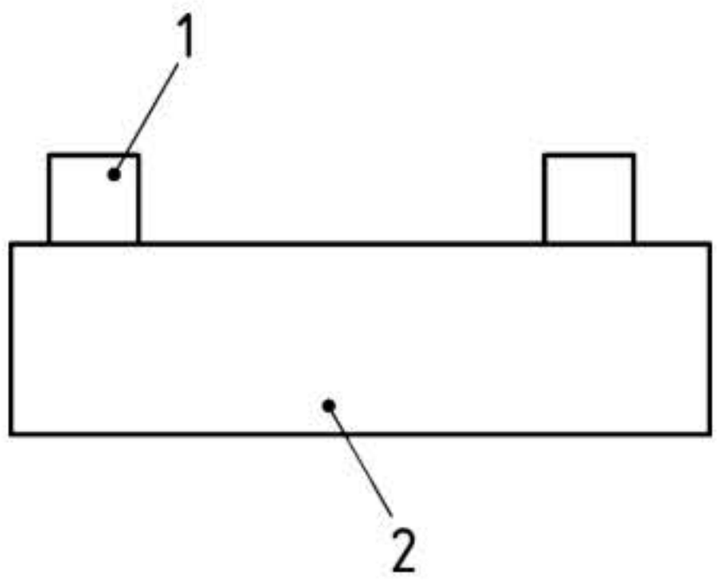
Note 1 to entry: See Figure 2.



Key

1 pick-up plate
2 load carrying device
3 pin

Figure 1 — Pick-up plate



Key

1 pick-up pad
2 platform

Figure 2 — Pick-up pad

3.2.12
roll off safety device
device that prevents the vehicle from rolling off the platforms of wheel support vehicle lifts in the event of involuntary movement of the vehicle

Note 1 to entry: The roll off safety device is not the single wheel stop but is the whole system that prevents the vehicle from falling off (i.e. both wheel stops when you have two, the single wheel stop when you have one ...).

3.2.13
wheel stop
part of roll off safety device at the end of a platform on vehicle lifts which opposes the movement of the wheel of the vehicle

3.2.14
end stop
mechanical stop that limits the movement of elements within maximum admissible values, ensuring the maintenance of the intended function of the system

3.2.15
control device
device through which the operator commands at least one of the working functions of the lift

3.2.16
fixed control
control device fixed to the structure of the lift or in any case set in a predefined fixed position when the lift is installed (e.g. fixed control console, controls installed on the walls of the workshop where the lift is installed)

3.2.17
mobile control
control device not fixed to the lift structure or somewhere else

3.2.18
remote control
handheld control device connected to the lift's electrical system via cable or wireless that allows the lift to be operated remotely from the main control

3.2.19
consensus control device
additional control having the sole function of confirming the command implemented by the main control

3.2.20
wheel free system
lifting unit which is used in conjunction with a pit or vehicle lift with platform lifting the whole vehicle and allows the wheels to be removed

3.3 Lift type

3.3.1
multiple lifting unit lift
combination of independent units lifts or two or more vehicle lifts matched to each other

Note 1 to entry: A mobile column lift or two or more lifts installed each one after in tandem with the other and synchronized with each other are examples of multiple lifting unit lift.

3.3.2
short stroke lift
floor mounted vehicle lift with a maximum vertical travel of not more than 500 mm, which is not designed for working under the raised load

Note 1 to entry: These lifts are different to wheel free systems according to 3.2.20.

3.3.3
long lifting system
lifting system consisting of several lifting units distributed over a distance of more than 15 m

3.3.4
scissor lift
vehicle lift where the vehicle is supported on its wheels or chassis by one or two platforms, supported on a single foldable supporting structure

3.3.5
double scissor lift
vehicle lift where the vehicle is supported on its frame by two separate platforms, which are moving vertically, each supported on two foldable supporting structures

3.3.6
single column lift
vehicle lift with a vertical supporting structure where a single lifting element is supporting a whole vehicle on its frame or on its wheels

3.3.7
two column lift
vehicle lift with a fixed vertical supporting structure where two lifting elements are supporting the vehicle on its frame or on its wheels

3.3.8
four column lift
vehicle lift where the vehicle is supported on its wheels by platforms rising and lowering along four vertical fixed columns

3.3.9
in-ground piston lift
vehicle lift where the vehicle is supported on its frame, axles or wheels by a single/multiple hydraulic lifting unit(s), partially or totally fitted below ground level

3.3.10
in-ground scissor lift
vehicle lift where the vehicle is supported on its frame, axles or wheels by a foldable structure, partially or totally fitted below ground level

3.3.11
mobile column lift
combination of independent lifting units, each with a vertical supporting structure supporting part of a vehicle on its frame or on a wheel, acting as one lift

Note 1 to entry: A mobile column lift is a special case of multiple lifting unit lift.

Note 2 to entry: A single independent lifting unit part of a mobile columns lift is not designed to raise a vehicle but shall be combined with other units to achieve that.

3.3.12
platform lift
vehicle lift where the vehicle is supported on its wheels or chassis by one or two separate platforms

3.3.13
rolling jack
auxiliary lifting device used typically to raise just one end of the vehicle

Note 1 to entry: A rolling jack cannot be used as a stand-alone device but shall always be used in conjunction with another lift, typically a platform lift or a 4 post lift.

Note 2 to entry: Synonyms for rolling jack are e.g. pit jack, jacking beam.

3.3.14
mobile vehicle lift
movable vehicle lift equipped with wheels, rollers, etc. such that it can be moved from one place to another without load and can fulfil its function without being fixed to the floor

3.3.15
manually driven vehicle lift
vehicle lift where the load carrying device is driven by manual effort

3.3.16
power-driven vehicle lift
vehicle lift where the load carrying device is driven by effort other than manual

3.3.17
mechanically driven vehicle lift
power-driven lift not using hydraulic nor pneumatic fluid power

3.4 Safety related parts

3.4.1
catching device
mechanical safety device which holds the load carrying device in case of failure of a lifting element

Note 1 to entry: See Figure 3.

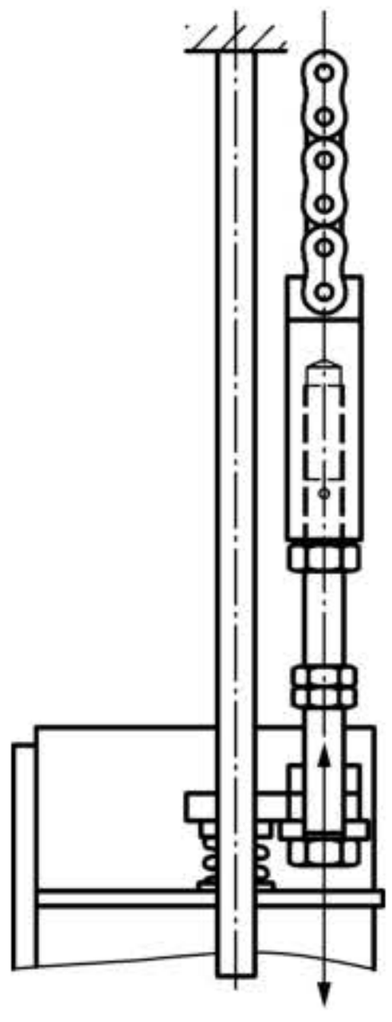


Figure 3 — Catching device

3.4.2
latch
device normally used to prevent unexpected movements in lifts operated by hydraulic/pneumatic cylinders

Note 1 to entry: A latch can e.g. consist of a ratchet and pawl device.

Note 2 to entry: See Figures 4 and 5.

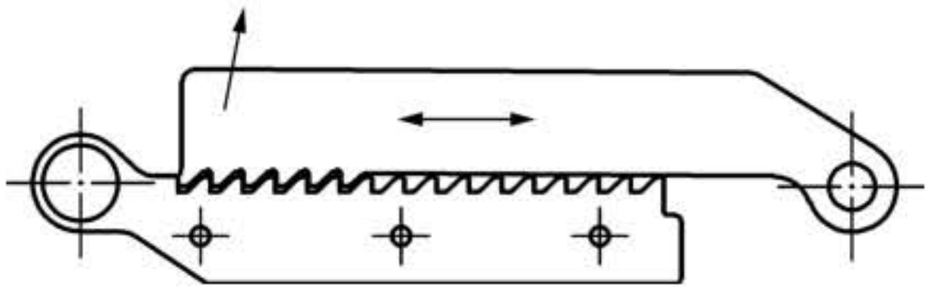


Figure 4 — latch consisting of hooks

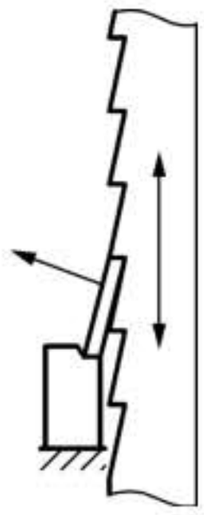


Figure 5 — latch consisting of pawl

3.4.3
pipe rupture valve
valve that limits the unintentional lowering speed of the lift in case of breakage of a hydraulic pipe

3.4.4
total hydraulic redundancy
characteristic of the hydraulic system of a lift with two or more hydraulic lifting elements for which any hydraulic leaks do not compromise the safety of the lift

3.4.5
holding device
device, which holds the load carrying device automatically in a stationary raised position

3.4.6
re-raising prevention device
device which prevents re-raising of load carrying device from the initial position in the event of failure of the lifting element

3.4.7
automatic brake
braking device which is normally held on and which is released only by application of power

Note 1 to entry: Operation of the braking device is also instigated automatically by releasing the lift controls and by interruption of the power supply.

3.4.8
self braking system
system which, due to its inherent resistance to movement, stops the movement of the load carrying device when the drive power is interrupted

3.4.9
safety switch
switch which performs a safety function as defined in 3.30 of EN ISO 12100:2010

Note 1 to entry: The whole of the specified opening of the contacts should be achieved by operation of the control mechanism through its intended travel using the force stated by the manufacturer of the switch (see K.2.1 of EN 60947-5-1:2017).

4 Safety requirements and/or measures

4.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause.

In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

4.2 Preventing unauthorised operation

Vehicle lifts shall be equipped with an accessible and fixed device that prevents unauthorized use after taking the lift out of operation (refer to Annex C).

4.3 Control devices

4.3.1 Hold-to-run control

Control devices shall be of the hold-to-run type. The functions of the command shall fulfil the conditions of performance level b of EN ISO 13849-1:2015. The stop-function shall comply with category 0 of 9.2.2 of EN 60204-1:2018.

4.3.2 Grouped control devices

If the control devices for more than one vehicle lift are grouped together in one position, each control device shall be clearly marked to show which vehicle lift it controls.

4.3.3 Logical operation

The control devices shall be designed so that the movement of the control and its location are consistent with its effect (refer to Annex C).

4.3.4 Marking

The direction of the movement of the load carrying device shall be permanently marked (refer to Annex C). The marking shall be suitable symbols or text and can be located on the control devices themselves or directly adjacent to them.

4.3.5 Unintentional operation

Control devices shall be protected from unintentional operation (refer to Annex C).

4.4 Controls

4.4.1 General

Control devices shall be designed and arranged so that the operator is not jeopardized by the lift or by the load and can keep watching the hazardous area, to avoid risk of harm to bystanders.

Where it is possible to control the lift by using more than one control device, there shall be measures to ensure that only one control has priority at any time. The priority shall be chosen by a selector switch, which enables only one control device at a time or, in the absence of such a selector switch, by automatic exclusion of the control device not operating when the prioritized one is activated.

Safety related parts in the selection system shall comply with performance level c category 2 of EN ISO 13849-1:2015.

4.4.2 Fixed controls

Fixed controls shall be designed and arranged so that they are within easy reach of a standing operator and should not be higher than 1,8 m from the floor level.

If the conditions are such that the hazardous area cannot be completely viewed by the operator at the fixed control, suitable control measures shall be provided so that:

— they allow the hazardous area to be viewed by the operator; or

— any bystander is effectively alerted to the risk associated with their presence in the hazardous area while the lift is moving.

This shall be done through the use of suitable devices (like audible/visual warning signal, refer to Annex C) and not just through warning instructions.

These devices shall operate in any condition where the risk is present.

This applies to the operation of both vehicle lifts and multiple lifting unit lifts.

For lifts installed in particularly limited areas (e.g. paint booth) the presence of a bystander is potentially negligible (and in any case the operator is still able to make sure that there are no risk situations) so additional warning devices may not be required.

For pinching and shearing risk see 4.17.

For further risk see Annex C.

4.4.3 Mobile controls

In relation to the risks associated with use, mobile controls can be divided into two categories:

a) devices that do not enable the operator to move inside the hazardous area; and

b) devices that enable the operator to move inside the hazardous area.

Devices of type a), like pendant mobile controls with short connecting cable, do not imply any special requirement other than those considered for fixed controls.

Devices of type b), usually called “remote controls”, can be divided in two categories, wireless or wired, but both are allowed only if the additional hazards are controlled (refer to Annex C).

The use of mobile controls shall be subject to the deactivation of main control, except emergency stop controls and eventual consensus control devices.

Special requirements for wireless remote controls:

— Wireless remote control, if active for the complete stroke, shall conform to Annex F. Alternatively, it can comply with Annex C of EN 13557:2003+A2:2008. In this case the stop function mentioned in EN 13557:2003+A2:2008, C.3, shall be designed to achieve performance level d or higher according to EN ISO 13849-1:2015.

— Only one wireless remote control can be connected to one lift at any one time. This can be either a fixed combination of remote controls and lifts or a programmable remote control that can be used with more lifts but is always limited to one lift at a time.

— In all cases it should be clear which lift the remote control is connected to before movement of the lift is started.

— Wireless remote controls shall be individually paired to the lift they operate.

— The pairing process shall be conducted by the operator and shall expire in such a way as to ensure that unintentional operation of a lift is impossible (refer to Annex C).

— The disconnection of a remote control should not affect any activation of an emergency stop. (the emergency state condition should remain until the emergency stop has been reset. Reset of emergency stop signal shall only be possible from the fixed/main control position).

— To identify any recognition modes for the connection between the wireless remote control and the lift, see Annex C.

4.4.4 Controlling multiple Lifting Unit Lift

If a single independent lifting unit of a multiple lifting unit lift is intended to be moved independently, a selection control shall be provided that enables:

a) the independent movement of each independent lifting unit; and

b) movements of all the independent lifting units together.

Other combinations of movements of the independent lifting units may also be incorporated and selected by the selection control.

The non-selected independent lifting units shall be prevented from operating.

4.4.5 Emergency stop device

The main switch can act as an emergency stop (refer to 5.3.3 and 10.7.3 of EN 60204-1:2018).

In a multiple lifting unit lift for rail-bound vehicles, each control position shall be equipped with an emergency stopping device which fulfils the requirements of EN ISO 13850:2015 and stops the movement of all lifting units within the limits given in 4.15c. The emergency stop function shall comply with performance level d of EN ISO 13849-1:2015.

On all other vehicle lifts, an emergency stopping device is not required because activation of it would not lessen the risk (due to the fact that it would not reduce the stopping time).

The stop-function shall comply with category 0 of 9.2.2 of EN 60204-1:2018.

If an emergency stop is fitted on other types of vehicle lifts, the safety related parts in the control system shall comply with performance level c of EN ISO 13849-1:2015.

4.4.6 Stopping device

Each control station shall be equipped with a separate device to stop all movements which have been initiated by a control. This device shall have priority over the start controls and be able to stop the movements also in case of one failure as mentioned in EN ISO 13849-2:2012.

If an emergency stopping device is fitted, a separate stopping device is not necessary.

4.5 Duplicated drive systems

Drive systems which are both power driven and manually driven shall be designed in such a way that neither drive can put the other drive into motion.

4.6 Speeds

The speed for lifting and lowering shall not exceed 0,015 m/s for vehicle lifts of rail bound vehicles (trains, trams, etc.) and 0,15 m/s for other vehicle lifts.

4.7 Structural design of the supporting structure

4.7.1 General

The design of vehicle lifts in relation to materials, construction and equipment shall be such that a satisfactory level of safety is achieved under all operating conditions including the failure situations described in this document. This shall be demonstrated by calculation. Use of the permissible stress method is allowable.

The stress, resulting from the most unfavourable load distribution, shall be calculated for each part which is structurally loaded according to all the applicable load combinations listed in Table 2. For permissible stresses refer to Annex B. The values of Annex B are given under the condition of 22 000 load cycles at rated load. If this value is exceeded, fatigue calculation shall be performed for structure and mechanism.

Wheel support vehicle lifts for road vehicles shall be designed in such a way that during normal operation the maximum inclination of the platforms in its longitudinal axes is limited to 1°.

On chassis supporting vehicle lifts loaded with rated load the inclination of the level of the pick up device shall not exceed 3° from the horizontal. For test methods refer to Annex G.

4.7.2 Loads and forces

4.7.2.1 Regular loads

a) Structural loads

The gravitational masses of components of the vehicle lift are used to calculate the structural loads.

1) Loads due to components which are not moving are considered to be static structural loads.

2) Loads due to moving components are considered to be dynamic structural loads.

b) Rated load/Lifting capacity

Excluding multiple lifting unit lifts, the rated load corresponds to the maximum weight of the vehicle that can be lifted and one shall refer to the normative vehicle or to the special vehicle in case of lifts mentioned in 4.7.4.4.

For multiple lifting unit lifts, where the vehicle is lifted by columns acting on the single wheel or axles but not necessarily on all of them simultaneously (e.g. mobile column lifts, acting on single-wheel or inground piston lifts, acting on single axle, ...), due to the variability of the configuration, it is not possible to refer to the normative vehicle so the "rated load" is replaced by the "lifting capacity", referred not to the whole vehicle but to the single lifting unit.

c) Dynamic forces

Dynamic forces are due to working movements such as raising, lowering and tipping in service. These shall be taken into account by multiplying the moved structural loads and the payload by the dynamic factor ϕ, which shall be calculated in relation to the nominal speed v in metres per second. An alternative to this is to take ϕ equals to 1,151 since the factor 0,34v is of the order 0,051 maximum.

$$\Phi = 1,1 + 0,34v$$

d) Manual forces

Manual force is produced by operators. This force shall be taken as 1 000 N acting horizontally at the height of the load carrying device.

For motor bike lifts this force shall be-not less than 500 N.

e) Effects of accessories

The designer shall take into account the effect that any approved accessories may have on the loading of the lift. (For example-rolling jack). Manual forces and dynamic forces do not act simultaneously and shall not be combined. Manual forces and static forces shall be combined.

4.7.2.2 Occasional loads – In-service wind

If the vehicle lift is designed for outside use, the influence of wind forces in the wheelbase direction shall be included in the stress calculation (see also 4.7.3) and overturning calculation (see also 4.7.6).

The maximum pressure of in-service wind is 125 N/m^2, which is related to a wind speed of 14 m/s (50,4 km/h).

The wind forces acting on the normative vehicle (refer to Table 3) shall be derived from Table 1.

Table 1 — Wind forces and stabilizing effects

Rated load/ Lifting capacity t	**Wind force F_W** kN		**Stabilizing weight effect** [kN] **and exposed surface** [m^2]	**Axle wind force ratio**		
	In service	Out of service		F_1/F_W	F_2/F_W	F_3/F_W
a) P ≤ 0,6	0,125	0,5	1	0,40	0,60	/
b) P ≤ 1	0,375	1,5	3	0,40	0,60	/
c) P ≤ 1	0,375	1,5	3	0,40	0,60	/
d) P ≤ 2,5	0,75	3	6	0,40	0,60	/
e) 2,5 < P ≤ 3,5	1	4	8	0,40	0,60	/
f) 3,5 < P ≤ 7,5	1,875	7,5	15	0,33	0,66	/
g) 7,5 < P ≤ 20	2,25	9	18	0,33	0,66	/
h) 20 < P ≤ 30	2,625	10,5	21	0,33	0,66	/
i) 30 < P ≤ 40	3	12	24	0,45	0,55	/
j) P ≤ 25	5,25	21	42	0,25	0,30	0,45
k) P ≤ 40	4,875	19,5	39	0,20	0,30	0,50
l) 40 < P ≤ 52	5,25	21	42	0,20	0,30	0,50
m) P ≤ 40	4,125	16,5	33	0,17	0,33	/
n) 40 < P ≤ 52	4,875	19,5	39	0,17	0,33	/
o) P ≤ 45	4,875	19,5	39	0,20	0,40	0,40

4.7.2.3 Exceptional loads

a) Out-of-service wind

If the vehicle lift is designed for outside use, the influence of wind forces in the wheelbase direction shall be included in the stress calculation (see also 4.7.3).

The maximum pressure of out-of-service wind is 500 N/m^2, which is related to a wind speed of 28 m/s.

The wind forces acting on the normative vehicle (refer to Table 3) shall be derived from Table 1.

This document assumes that an operator will lower a raised vehicle to the ground level or as low as possible when he/she is not working on it. A corresponding requirement shall be written in the operation instructions if the vehicle lift is designed for outside use.

For the overturning stability calculation, a stabilizing weight effect of 1 kN for each square metre of exposed vehicle surface to the wind can be considered as stabilizing moment (refer to Table 1).

b) Action

1) of the catching device; or

2) of the re-raising prevention device.

c) Test load for:

1) dynamic test (see 5.6.2);

2) static test (see 5.6.3).

4.7.3 Load combinations

The loads defined in 4.7.2 shall be combined and classified as indicated in Table 2.

Table 2 — Load combinations

Load	Clause	Load combination						
		A1	A2	B1	B2	C1	C2	C3
Regular loads	4.7.2.1							
Structural loads – static	a1	1	1	1	1	1	1	1
Structural loads – dynamic	a2	ϕ	1	ϕ	1	1	ϕ	1
Rated load/lifting capacity	b	ϕ	1	ϕ	1	1	ϕ	1
Manual forces	d	-	1	-	1	-	-	-
Effect of accessories	e	ϕ	1	ϕ	1	1	1	1
Occasional loads - In-service wind	4.7.2.2	-	-	1	1	-	-	-
Exceptional loads	4.7.2.3							
Out-of-service wind	a	-	-	-	-	1	-	-
Action of the catching device	b1	-	-	-	-	-	1	-
Action of the re-raising prevention device	b2	-	-	-	-	-	-	1

Key

Load combination A1: Normal operation (raising/lowering) without wind or special forces

Load combination A2: Normal operation (service/repair work) without wind or special forces

Load combination B1: Normal operation (raising/lowering) with wind force

Load combination B2: Normal operation (service/repair work) with wind force

Load combination C1: Vehicle lift out of service with wind force

Load combination C2: Action of the catching device

Load combination C3: Action of the re-raising prevention device

ϕ: Multiplication factor according to 4.7.2.1.

4.7.4 Load distribution

4.7.4.1 General

Vehicle lifts shall be designed, manufactured and used only referring to the type of vehicle support specified by the manufacturer. Proper instruction shall be given in the information for use.

By limiting the considerations to normal vehicle lifts only (for lifts for rail bound vehicles as well as those for special vehicles, see 4.7.4.4) the load distribution, related to the rated load, that is to be considered in the structural calculations of the lift, depends on the type of lift.

For this purpose, 3 lift categories are identified:

a) Wheel support vehicle lifts (e.g.: lift with platforms) excluding those in category c;

b) Chassis supporting vehicle lifts (e.g.: two column lifts);

c) Multiple lifting unit lifts, acting on single wheel or single axle (e.g.: mobile column lifts, inground truck piston lifts).

For lifts of categories a) and b), the load distribution refers to normative vehicle, according with 4.7.4.2 and 4.7.4.3.

For category c), as it is not possible to refer to the normative vehicle, reference shall be made to the lifting capacity of the single lifting unit.

Even if a lift (category a) und b)) is equipped with overload protection device, the rated load shall only be defined on the basis of the normative vehicle (and therefore in reference to 4.7.4.2 and 4.7.4.3). The manufacturer can, however, state the possibility of lifting higher loads in relation to different load distributions as long as they are compatible with the effects of the load limiting devices and considered in the dimensioning of the load bearing parts of the lift.

These higher liftable loads shall be presented in such a way as not to create confusion with the actual rated load of the lift, which shall only be defined in reference with the normative vehicle.

The safety related parts in the control system of overload protection devices shall comply with Pl c according to EN ISO 13849-1:2015.

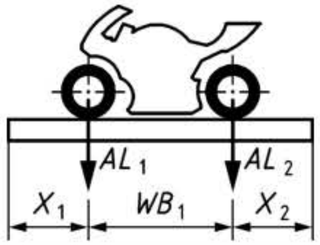
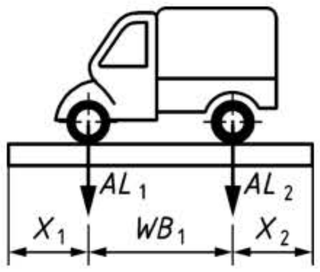
4.7.4.2 Wheel support vehicle lift for road vehicles

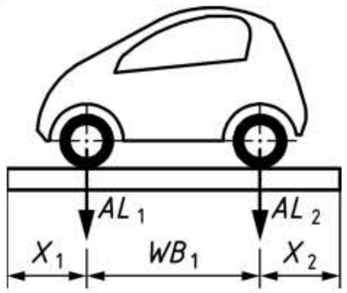
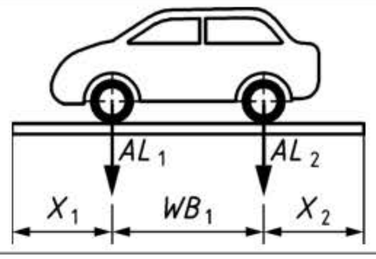
The rated load shall be distributed according to normative vehicle data as shown in Table 3. Consideration shall be given in each case to normative vehicles both less than and equal to the rated load to ensure that the most adverse loading situations are considered.

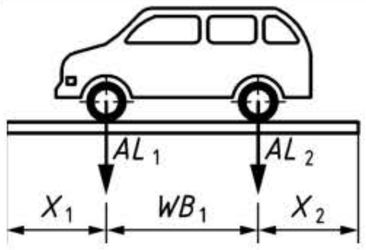
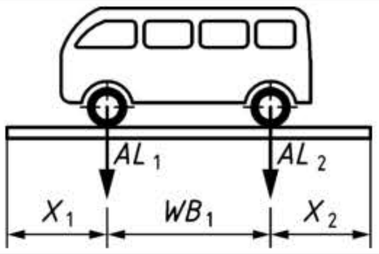
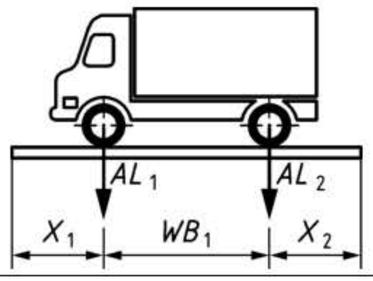
Vehicle positioning on platforms shall be considered in both directions, with the vehicle track symmetry axis and the platforms' symmetry axis coincidental and in any case in the most burdensome positions in relation to the elements being checked, also including those relating to the vehicle entry and exit phases from the lift.

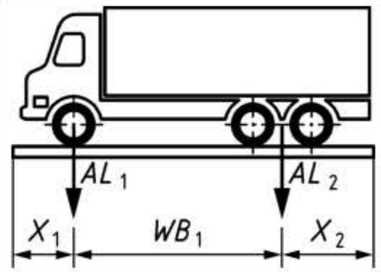
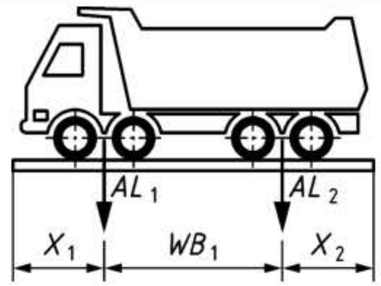
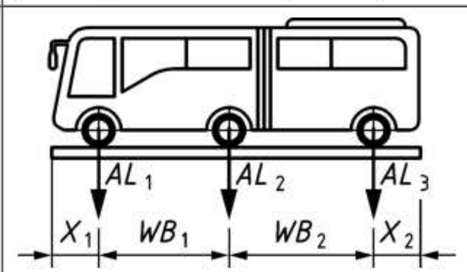
When calculating for platforms, the plate stresses caused by supporting the loads shall be taken into account assuming that the load is uniformly distributed on a square or circular area at a pressure of 50 N/cm^2. In the case of a virtual axle the force to be considered for calculating plate stresses shall be equally distributed on each axle. Plate stresses need not be considered if the plain area between any two flanges or supporting sections is not considered when calculating the supporting cross section.

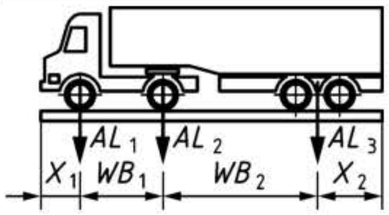
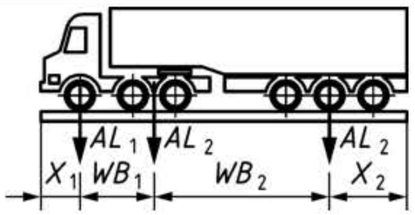
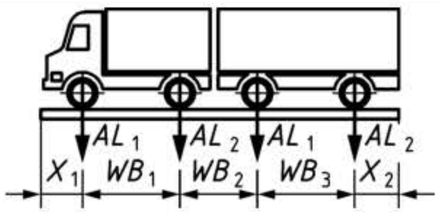
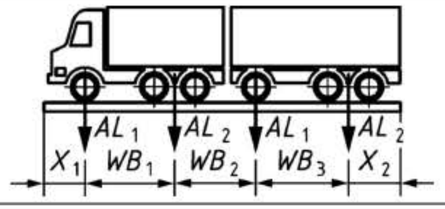
Table 3 — Normative vehicle

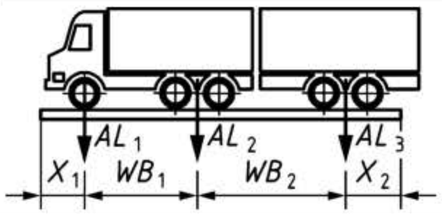
		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
a	P ≤ 0,6	-Two wheeled motorcycles Categories L1, L3	2		650	NA	1500	N/A	N/A	0,4	0,6	N/A	300	300
b	P ≤ 1	-Three wheeled motorcycles -Two wheeled motorcycles with side car -Powered tricycles Categories L2, L4, L5	2		450	1200	1600			0,4	0,6	N/A	200	200

		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
c	P ≤ 1	-Light quadricycles (includes, light quadri mobiles, light on road quads, …) -Heavy quadricycles (includes heavy quadri mobiles, heavy on roads, heavy all terrain quads, side by side buggies, …) Categories L6, L7,	2		550	1200	1750	N/A	N/A	0,4	0,6	N/A	250	250
d	P ≤ 2,5	-Passenger cars Categories M1, M2	2		770	1500	2500	N/A	N/A	0,4	0,6	N/A	300	300

		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
e	2,5 < P ≤ 3,5	-Passenger cars, - (includes SUV, vans, campers, motorhomes, ...) -Light truck Categories M1, M2, N1	2		770	1600	3000	N/A	N/A	0,4	0,6	N/A	300	300
f	3,5 < P ≤ 7,5	-Bus -Trucks Categories M3, N_2	2		770	1700	3000	N/A	N/A	0,33	0,66	N/A	300	300
g	7,5 < P ≤ 20	-Lorries Categories, N_2, N3	2		900	1800	3500	N/A	N/A	0,33	0,66	N/A	500	500

		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
h	20 < P ≤ 30	-Lorries Categories, N3	3		1050	1900	4000	N/A	N/A	0,33	0,66	N/A	500	1000
i	30 < P ≤ 40	-Dumper trucks/Tipping vehicles Categories, N3	4		1050	1900	4500	N/A	N/A	0,45	0,55	N/A	1000	1000
j	P ≤ 25	-Articulated busses Categories, M3	3		1050	1800	5500	6500	N/A	0,25	0,3	0,45	500	500

		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
k	P ≤ 40	-Articulated lorries Categories, N3, O3, O4	4		1050	1900	3500	7000	N/A	0,2	0,3	0,5	500	1000
l	40 < P ≤ 52	-Articulated lorries Categories, N3, O3, O4	≥ 5		1050	1900	3500	7000	N/A	0,2	0,3	0,5	500	1600
m	P ≤ 40	-Lorries with trailer Categories, N3, O3, O4	4		1050	1900	3500	3000	3500	0,17	0,33	N/A	500	500
n	40 < P ≤ 52	-Lorries with trailers Categories, N3, O3, O4	≥ 5		1050	1900	4000	3000	4000	0,17	0,33	N/A	500	1000

		NORMATIVE VEHICLES												
							Wheelbase			Axle load ratio			Min distance	
It	Rated Load (t)	Vehicle Type Vehicle Category	No. of axles	Normative vehicle	Wheel diam. (mm)	Wheel track WT (mm)	WB1 (mm)	WB2 (mm)	WB3 (mm)	AL1	AL2	AL3	X1 (mm)	X2 (mm)
o	P ≤ 45	-Lorries with trailers Categories, N3, O3, O4	≥ 5		1050	1900	4000	5000	N/A	0,2	0,4	0,4	500	10000

4.7.4.3 Chassis supporting vehicle lift for road vehicles

The rated load shall be distributed according to normative vehicle schematised in a loading rectangle with the following characteristics:

A) Load distribution

The load ratios between the front and rear load carrying points shall be (in both directions):

— For rated loads ≤ 3,5 t: 0,4-0,6 (maximum load one pick-up point 0,3 rated load)

— For rated loads > 3,5 t: 0,25-0,75 (maximum load one pick-up point 0,375 rated load)

B) Load rectangle dimensions

The rated load shall be distributed on the four corners of a rectangle with the following dimensions (see Figure 6):

— For rated load ≤ 3,5 t: 100 cm (wheel track) x 140cm (wheelbase)

160 cm (wheel track) x 140cm (wheelbase)

— For rated loads > 3,5 t: 100 cm (wheel track) × 180 cm (wheelbase)

160 cm (wheel track) x 180 cm (wheelbase)

The load rectangle wheel track symmetry axis and the lift wheel track symmetry axis are coincidental.

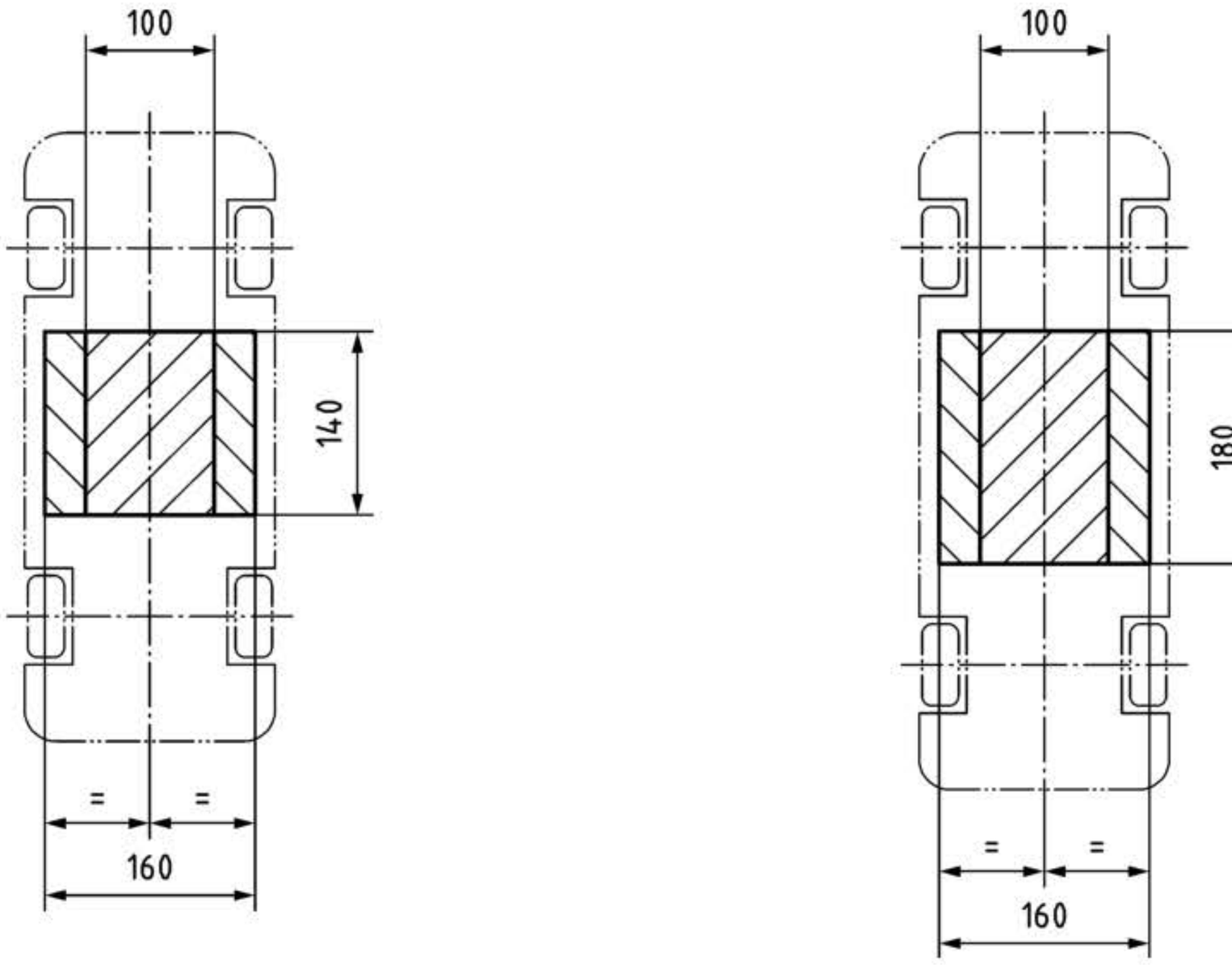


Figure 6 — Load rectangle

The load rectangle shall be positioned on the lift in the worst condition related to the part of the lift for which the calculation is done (this means that different positions could be considered according to the parts being tested).

In particular:

— In platform lifts:

  - if this is variable in length, the platform shall be considered at its maximum length.

— In lifts with carrying arms:

  - the load rectangle shall be positioned with the long arm to the maximum length rotated so as to intercept the distance of 100/160 cm in the wheel-track direction, and the short arm extended as far as necessary to intercept the distance of 100/160 cm and at the same time reach the distance 140cm (rated load ≤ 3,5 t) or 180 cm (rated load > 3,5 t) in the wheelbase direction. If it is not possible to meet the wheelbase distances then then it is acceptable to be as close as possible providing the final dimension is never less than either 140cm or 180cm, whichever case refers. (refer to Annex C).

Pick-up plates and their shafts shall be designed to suit the load acting at a point halfway between the centre and the outside edge of the pad.

4.7.4.4 Vehicle lifts for special vehicles

For a vehicle lift designed to lift special vehicles:

a) The design of the lift shall be in accordance with the actual load distribution of the special vehicle to be lifted. If the lift is intended for use with different special vehicles, the distribution shall suit the most unfavourable condition.

b) All lifts shall be equipped with clearly understood load distribution plates related with the special vehicle which is the intended use of the lift of sufficient size and placed in conspicuous locations.

c) If the lift is intended also for use with normal vehicles a second rated load shall be specified and the load distribution in this case shall be according with 4.7.4.2 and 4.7.4.3.

The rated load defined for special vehicles shall not be confused with the rated load referred to normal vehicles.

4.7.4.5 Combination with rolling jacks or other additional interchangeable equipment

If the vehicle lift is intended to be used in combination with pit jacks/rolling jacks or other additional interchangeable equipment these special forces and conditions shall be taken into consideration by design of the vehicle lift.

4.7.5 Lifting elements

4.7.5.1 Catching devices and mechanical re-raising prevention devices

If catching devices or re-raising prevention devices are activated, no permanent deformations shall occur in any part required for continued normal operation.

If permanent deformation occurs in such a device after activation, exact instructions shall be given in the operation manual with regard to the measures to be taken (e.g. replacement of the part, removal of burrs).

4.7.5.2 Rope drives

Steel wire ropes for rope drives shall comprise a minimum of 114 single wires. The nominal tensile grade of each wire shall be at least 1 570 N/mm² but not exceed 1 960 N/mm².

The tensile grade of terminations shall be a minimum of 80 % of that of the rope.

For the terminations of wire ropes the following shall be used:

— splices;

— aluminium press ferrules;

— non-ageing steel press ferrules;

— wedge socket anchorages.

The minimum breaking force of the wire ropes shall be shown on a certificate.

Classification of rope drives mechanisms shall be calculated according to the total duration of the full load cycles the lift is designed for, according to the vertical displacement and the nominal vertical speed:

$$T_f = t_{av} \cdot C_f$$

where

C_f is the design number of full load cycles;

$t_{av} = \frac{\Delta H}{v_{avr}} + \frac{\Delta H}{v_{avl}}$ is the average duration of a cycle;

ΔH is the vertical stroke;

v_{avr} is the average raising speed in m/min;

v_{avl} is the average lowering speed in m/min.

The M-class of the rope drives mechanism is then established by matching the calculated total duration of the full load cycles the lift to the closest (higher) nominal value of T_f in Table 4.

Table 4— Total duration of use T_f for full load cycles

M-class	Total duration of full load cycles T_f h
M1	100
M2	200
M3	400
M4	800
M5	1600
M6	3200
M7	6400
M8	12500

Wire rope drives, including drum and pulley diameters, shall be calculated according to ISO 16625:2013 using the classification of mechanism calculated for the rope drives mechanism.

Load spectrum of rope synchronization mechanisms, Kps, shall be calculated according to ISO 4301-1:2016.

Unless otherwise calculated by the designer, the load spectrum of rope synchronisation mechanisms shall consider a lateral imbalance of one fourth (1/4) of the rated load applied in 15 % of the expected load cycles.

Classification of rope synchronization mechanisms shall be calculated according to the load-spectrum-weighted duration of the synchronisation cycles the lift is designed for, according to the vertical displacement and the nominal vertical speed:

$$T_{fs} = t_{av} \cdot C_f \cdot K_{ps}$$

The M-class of the rope synchronisation mechanism shall be established by matching the load-spectrum-weighted duration of the synchronisation cycles the lift is designed for to the closest (higher) nominal value of T_f in Table 4.

Wire rope used for synchronization and their drum and pulley diameters shall be calculated according to ISO 16625:2013 using the classification of mechanism calculated for the rope synchronization mechanisms.

4.7.5.3 Chain drives

The minimum breaking load of chains shall be at least four times the maximum possible static load, with the rated load in the most unfavourable position. Proof of minimum breaking load shall be provided in the form of a manufacturer's certificate.

Chain wheels and sprockets with undercut teeth shall not be used.

The tensile strength of terminations shall be a minimum of 80 % of that of the chain.

4.7.5.4 Hydraulic and pneumatic drives

Hydraulic and pneumatic cylinders, pipes and their connections which may be subjected to the maximum pressure permitted by the pressure relief valve shall be designed to withstand at least:

— two times this pressure in hydraulic drives;

— three times this pressure in pneumatic drives

without permanent deformation.

Hoses, air bags and bellows shall be dimensioned in order to withstand a bursting pressure equal to at least three times the maximum pressure permitted by the pressure relief valve.

4.7.5.5 Screw-drives

The lead screw mechanism shall be designed to prevent separation of the load carrying device from the lifting element during normal use.

Each spindle shall be fitted with a load bearing nut and an unloaded safety nut or other constantly active safety device. The safety nut shall only be loaded if the load bearing nut fails.

Screw-drives using recirculating ball systems may use a catching device according to 4.13 instead of safety nuts.

Lead screws shall be fitted with devices at both ends to prevent the load bearing and safety nuts from leaving the threaded portion of the lead screws.

The lead screw material shall have a higher abrasion resistance than the load bearing nut material. For drives using recirculating ball systems other criteria for the materials involved are valid.

Load bearing nuts shall provide a life cycle suitable for garage use and according to user expectations. Safety nuts shall be calculated according to load combination C2 in Table 2.

4.7.5.6 Mechanical connections of several lifting units

If a mechanical synchronization device (torsion bar, synchronization rope etc.) is used to control the height of the load carrying devices of different lifting units, this device, including any mechanical devices shall be able to remain safe and not cause any hazard when subject to the worst load differences that can or will be possible between the load carrying devices including failure of a lifting element.

4.7.6 Proof of stability against overturning

Lifts which are not anchored to the ground are considered stable if the stabilizing moments, M_s are greater than the tilting moments, M_t multiplied by a safety factor. If the vehicle weight acts to stabilize the lift then a stabilizing weight can be considered in the calculation. The stabilizing weight effect of each type of normative vehicle is shown in Table 1. All load combinations enumerated in 4.7.3 shall be investigated with forces acting in their most unfavourable direction. The following conditions shall be fulfilled:

$$Case\ A: 1,3 \times M_t \leq M_s$$

$$Case\ B: 1,2 \times M_t \leq M_s$$

$$Case\ C: 1,1 \times M_t \leq M_s$$

For lifts which are anchored to the ground the calculation of anchor bolts shall be done accordingly with 4.7.4 load distribution.

4.8 Drive system

4.8.1 Preventing uncontrolled motion

Vehicle lifts shall be provided with an automatic device which prevents uncontrolled motion of the load carrying device and which operates at least above the first 500 mm of vertical travel of the load carrying device from the initial position (refer to Annex C).

Vehicle lifts designed to be used over a pit or over a lift as wheel free systems shall fulfil this requirement throughout the full stroke of the load carrying device.

In case of failure, involuntary movements may be possible if they occur at slow speed ($v < 10$ mm/sec) and are limited by suitable safety devices (see 4.13, 4.14, 4.15).

Short stroke lifts do not fall within the scope of this requirement (refer to Annex C).

4.8.2 Preventing inadvertent moving from stationary condition when raised

Where lifts are designed for people to stand under the vehicle and load carrying devices when the lift is not moving, the lifting elements operating those carrying devices, or the carrying devices themselves, shall have an automatic device which keeps them stationary by self-locking means (refer to Annex C).

4.8.3 Additional requirements for mechanical drives

4.8.3.1 Derailment protection

Pulleys and wheels for ropes and chains shall be provided with derailment protection. This shall be designed such that the rope or chain cannot pass between the derailment protection and the pulley or wheel.

4.8.3.2 Safety at nip points

Guards shall be provided to prevent access to wire rope and chain nip points.

When it is foreseen (e.g. maintenance) that fixed guards will be removed regularly then the fastenings shall remain attached to the guards or to the vehicle lift.

4.8.3.3 Tension regulation

If two or more ropes or chains are acting at one point it shall be possible to regulate the tension in each.

4.8.4 Additional requirements for hydraulic drives

4.8.4.1 General

The requirements of EN ISO 4413:2010 shall be fulfilled.

4.8.4.2 Pressure relief valve

The hydraulic system shall be provided with a pressure relief valve. If different maximum pressures are used in separate circuits of the hydraulic system, then one pressure relief valve shall be provided for each circuit. The pressure relief valve shall be the first valve in any circuit. The adjustment of the pressure relief valve shall only be possible by means of tools and protection shall be provided which prevents unauthorised adjustment.

Pressure relief valves shall be adjusted to act at a pressure which is not more than 10 % above that produced when operating with the rated load.

4.8.4.3 Bleeding

It shall be possible to bleed the hydraulic system.

4.8.4.4 Connection for pressure gauge

In all hydraulic systems there shall be a connection for a pressure gauge at an accessible location.

4.8.4.5 Filter

In all hydraulic systems there shall be a device that filters the hydraulic fluid in the system. There shall also be an initial filter at the hydraulic fluid reservoir tank filler to prevent the ingress of contaminants and particles into the tank.

4.8.4.6 Fluid level control

Hydraulic tanks shall be provided with means of indicating the actual level and the minimum permissible fluid level.

4.8.4.7 Size of the fluid tank

Fluid tanks shall be of sufficient size such that their capacity exceeds the displaced volume of the related lifting elements by at least 10 %.

4.8.4.8 Gas loaded accumulator

If a gas loaded accumulator creates the necessary pressure for the hydraulic bearing device, the motion shall automatically stop as soon as the allowable minimum liquid level in the tank is reached.

4.8.5 Additional requirements for pneumatic drives

4.8.5.1 General

The requirements of EN ISO 4414:2010 shall be fulfilled.

4.8.5.2 Holding device

If the vertical travel of the load carrying device is greater than 500 mm then the vehicle lift shall be fitted with a catching device. Note this is in order to restrict the hazard of unintended motion of the load carrying device (refer to Annex C). Vehicle lifts designed to be used over pits or as a wheel free system shall fulfil this requirement throughout the travel of the load carrying device.

4.8.5.3 Pressure relief valve

The pneumatic system shall be provided with a pressure relief valve.

If different maximum pressures are used in separate circuits of the pneumatic system, then one pressure relief valve shall be provided for each circuit. The pressure relief valve shall be the first valve in any circuit. The adjustment of the pressure relief valve shall only be possible by means of tools and protection shall be provided which prevents unauthorised adjustment.

A non-return valve shall be located between the pressure relief valve and the cylinder.

4.8.5.4 Pressure reduction

If the pressure created by the pressure generator is greater than the adjusted pressure of the pressure relief valve, a device shall be installed that will automatically reduce the generated pressure (refer to Annex C).

4.8.5.5 Hot working

Pneumatic lifts with air bags and bellows as lifting element which are intended to be used in connection with hot works (welding, grinding, etc.) shall have protection against damage, for example by covering the bellow.

4.8.5.6 Use in low temperatures

Vehicle lifts which are intended to be used at a temperature below + 10 °C shall be designed so that ice formation in the pneumatic system and pneumatically operated catching devices is prevented, for example by the metering of spirits.

4.8.5.7 Moisture reduction

The pneumatic system shall be equipped with a moisture reduction device.

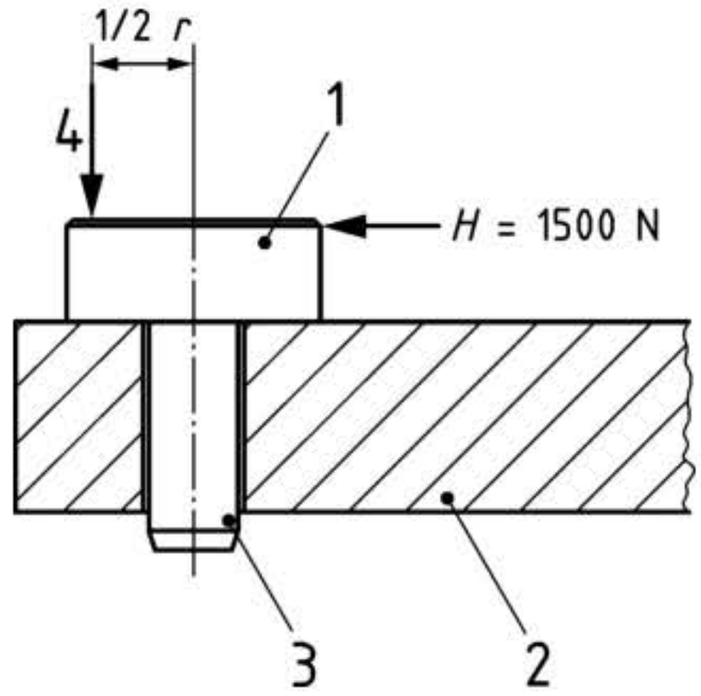
4.9 Load carrying devices

4.9.1 Unintended motion of the load carrying device

Load carrying devices shall be designed in order to prevent swinging, inadvertent tilting, rotating or shifting.

4.9.2 Vehicle pick-up-plates

Pick-up-plates and pad extensions shall engage with the basic carrying member so as to prevent it from overturning when subject to a horizontal force of H = 1 500 N, applied in the most unfavourable direction, when the pickup plate is loaded with a vertical load equal to the maximum pick-up point load as defined by 4.7.4.3 a) and b). The centre of gravity of the vertical load shall be considered to act on the pick-up-plate at 50 % eccentricity and the plate adjusted to the maximum height (see Figures 7 and 8). In the case of pad extensions only one shall be used at each lifting point (see Figure 9).

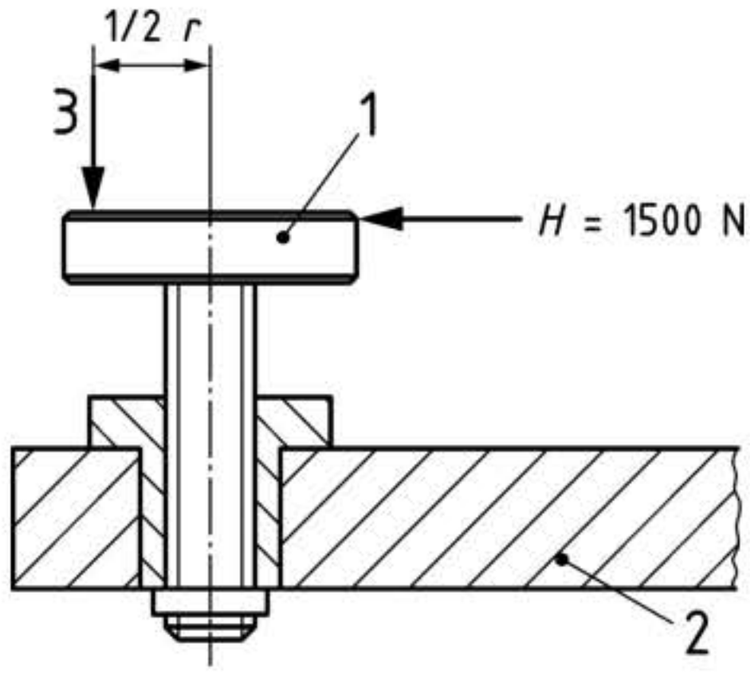


Key

1 pick-up plate
2 load carrying part
3 pin
4 vertical load
H horizontal force
r radius of the pick-up plate

Figure 7 — Pick-up plates

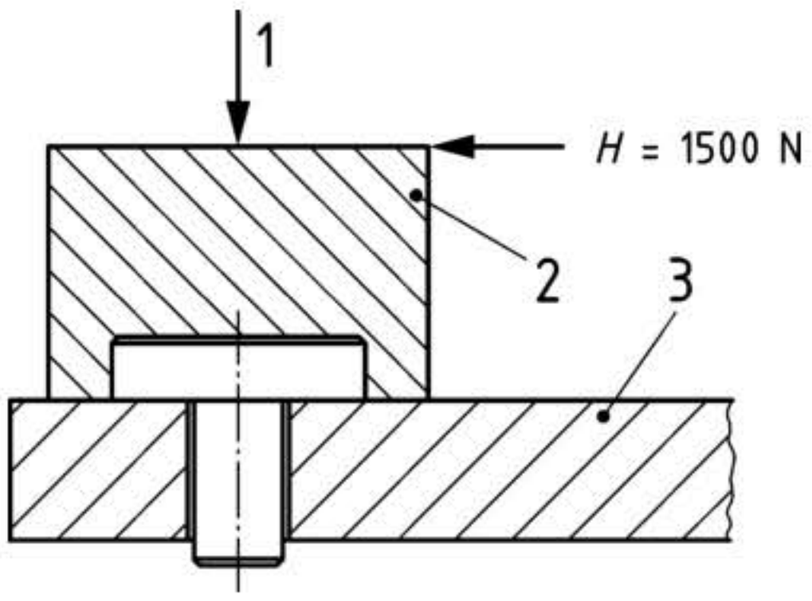
Vertically adjustable pick-up plates with threaded spindles shall be self-braking and shall be prevented from unscrewing (see Figure 8).



Key

1 pick-up plate
2 load carrying part
3 vertical load
H horizontal force
r radius of the pick-up plate

Figure 8 — Adjustable pick-up plates



Key

1 1/3 of the rated load
2 pad extension
3 load carrying part
H horizontal force

Figure 9 — Pad extension

4.9.3 Vehicle pick-up pads

If pick-up pads are used on the carrying device of the lift, the following requirements shall be observed:

a) Pick-up pads shall be prevented from sliding, for example with an interlocking or friction surface between the pick-up pad and the carrying device of the lift. This system shall be capable of withstanding a horizontal force of $H = 1\,500$ N, applied in the most unfavourable position and condition (e.g. oil between pad and carrying device), and with the lift loaded with $^1/_3$ of the rated load, without giving rise to movement of the pad.

b) The pick-up pads shall be conical or cubic in order to ensure a safe and clear use. The maximum ratio between height of the pad and the diameter of the largest circle which could be inscribed in the base of the pick-up pad shall not exceed 1:1.

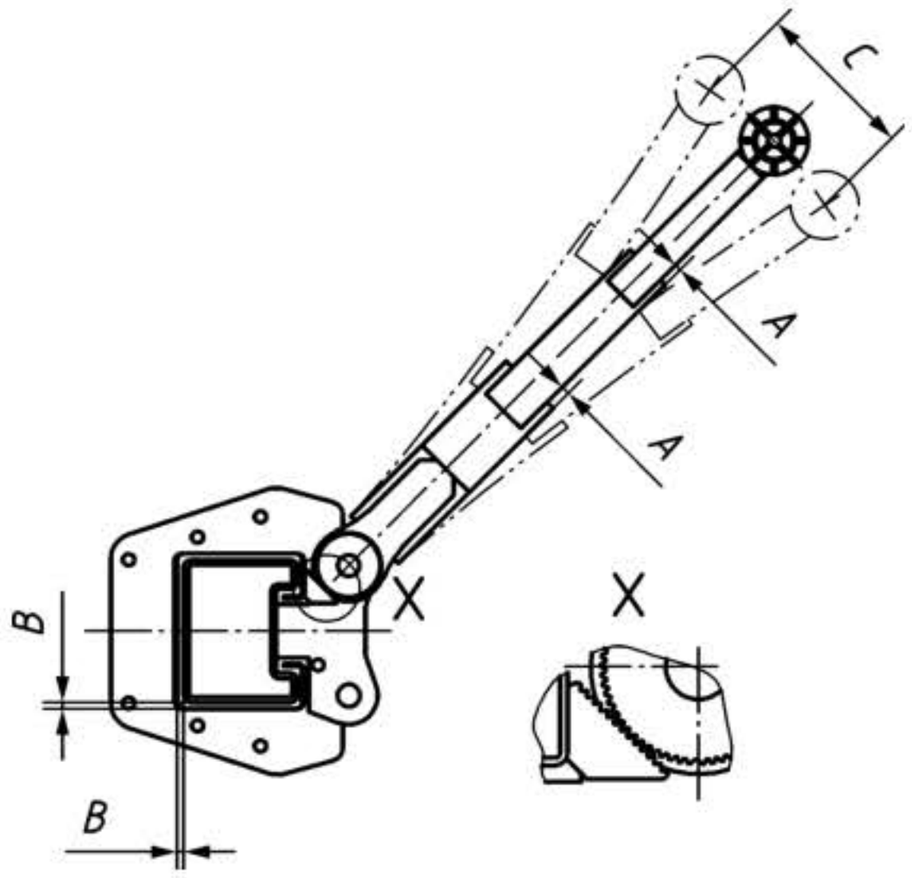
4.9.4 Locking systems of carrying arms

Carrying arms shall be equipped with automatic mechanical restraint devices that prevent the arms from swinging inadvertently, excluding allowable free play, and which operate, regardless of load, above the first 300 mm of vertical travel. Vehicle lifts designed to be used over pits or as a wheel free system shall fulfil this requirement throughout the travel of the load carrying device.

If this locking system operates in discrete steps, the step increment at the end of a fully extended arm, excluding allowable free play, shall not be greater than the inscribed diameter of the pick-up plate.

The total allowable free play in the arm locking system and the telescopic arms at the fully extended arm (excluding the play between the rest of the load carrying device and the supporting structure, see Figure 10, referring to 2 post lifts but the concept is to be intended generally for any kind of lift with carrying arms) shall not exceed 10 % of the length of the total telescoped arm, but in no case exceed 150 mm (tested with a force of 150 N, acting in both directions, and rest of the load carrying device locked to the supporting structure of the lift).

It shall not be possible to lock the arm locks in a disengaged condition above 300 mm of travel.



Key

A play to be considered

B play not to be considered

C free movement not to exceed 150 mm

Figure 10 — Carrying arm

Arm locking system shall be designed with reference to a force of 4,5 % of the rated load capacity of the lift (or in any case not less than 1500N) acting horizontally at the load carrying point, in the most unfavourable orthogonal direction, with the carrying arm fully extended.

The locking system shall resist to a proof test according with Annex I.

Extendable parts of carrying arms shall be equipped with end stops, preventing the arm becoming disengaged. The necessary hand force to extend the arms shall not exceed 200 N. To perform tests of the end stop, refer to Annex J.

4.9.5 Prevention of rolling off

Wheel support vehicle lifts shall have a roll off safety device that prevents the vehicle from falling caused by involuntary movement of the vehicle itself.

The roll off safety device is in general composed of several wheel stops.

All platforms shall have wheel stops on both ends which can be fixed in active position or mobile with automatic engagement after a vertical travel of the platform of 0,75 m and shall be at least 10 % of the wheel diameter (refer to Table 3) or 0,1 m, whichever is larger, above the surface of the platform.

The requirements for roll off safety device in the case of lifts for railway vehicles shall be evaluated according to the specific situations and agreed with the customer.

The roll off safety device shall function correctly in all cases provided in Table 3. In particular, all components shall not deform and shall keep their position to ensure the effectiveness of the device.

The roll off safety device shall be tested to resist an overall horizontal force of 20 % of the rated load, without permanent deformation and resist an overall horizontal force of 30 % of the rated load without breakage.

Alternatively, to the test a calculation of the roll off safety device is acceptable, where the resulting forces from a horizontal force Fs of 20 % of the rated load (refer to Annex H) shall be used.

In case of lifts with two platforms the single wheel stop mounted on the end of each platform shall resist a horizontal force equal to 10 % of the rated load (applied in the most severe way: usually at the point of maximum height corresponding to the point of contact with the vehicle wheel) without permanent deformation and resist a horizontal force of 15 % of the rated load without breakage.

Alternatively to the test, a calculation is acceptable, where the resulting forces from a horizontal force Fs of 10 % of the rated load for each end stop shall be used.

For further information and test method regarding roll-off stopping devices refer to Annex H.

4.10 Additional requirements for lifts with balconies

Vehicle lifts with integrated accompanying or stationary elevated front or side balconies higher than 1 m above the ground shall be equipped with guards to prevent people falling from the balconies.

The guard shall, as a minimum, consist of rigid guard-rails at least 1,1 m high, rigid toe guards at least 0,15 m high and rigid intermediate guard-rails not further than 0,5 m from either guard-rail or toe guards.

It shall be possible to secure movable parts of the guards against unintended motion during their operation. Swinging or tilting parts shall be inward opening.

When it is foreseen (e.g. maintenance) that the fixed guard rails will be removed regularly then the fastenings shall remain attached to the guards or to the machine.

Protection devices are not necessary in the following cases:

a) around the normal openings required for working under the vehicle;

b) at stationary balconies on the sides facing the carrying device.

The surface of elevated front and/or side balconies shall be non-slip. Holes, spaces or piercings in the balcony surface shall be no larger than would allow a sphere of 0,02 m diameter to pass through.

For the prevention of trapping between moving parts refer to 4.17.3.

4.11 Limiting the travel of the load carrying device

Before the load carrying device reaches its extreme end positions its motion shall be stopped.

Hydraulic or pneumatic cylinders which directly carry the load carrying device shall have a mechanical stop or an overflow which limits the lifting height.

Vehicle lifts using hydraulic or pneumatic cylinders in which the load carrier is completely or partly carried by ropes or chains without incorporating a mechanical stop at the cylinder shall limit the lifting height by switching off the corresponding control circuit.

For mechanically driven vehicle lifts devices shall be provided which switch off the corresponding control circuit at the normal limits of the raising and lowering movement.

Mechanically driven vehicle lifts shall also be provided with mechanical stops or safety switches at both extremes of travel to give additional safety in the event of failure of the normal limit devices. Failure of the upper normal limit device and/or actuation of a safety switch shall result in the lowering of the load being permitted but subsequent re-raising from the initial position prevented.

4.12 Unintended blocking of the load carrying device

Unintended blocking of load carrying device in lowering movement shall be detected to avoid:

a) the risk of asynchronization of carrying devices in case of lifts with more than one lifting units;

or

b) slack or free play between lifting elements which can lead to the risk of unexpected fast and uncontrolled fall of load bearing device when the cause of the slack disappears.

Appropriate safety devices shall be provided to detect the unintended blocking of the load carrying device and stop the downward movement in such a way that:

c) the possible asynchronization of the load carrying device is limited to a maximum of 100 mm (see 4.15);

and

d) the possible free fall of the load carrying device is limited to a maximum of 50 mm.

Motion in the opposite direction shall still be possible.

These safety devices shall be operational after a vertical travel of the load carrying device of, at least, 500 mm at any stationary position unless the lift is installed over a pit or over a lift (wheel free lift) in which case the requirement shall be satisfied throughout the full stroke of the loading carrying device (refer to Annex C).

Short stroke lifts do not fall within the scope of this requirement.

For test method refer to Annex E.

4.13 Safety against rupture of mechanical lifting elements

Vehicle lifts in which the load carrying devices are held by mechanical lifting elements shall be designed to prevent the load carrying devices from lowering more than 100 mm in case of rupture of the mechanical lifting elements. This shall be operational after a vertical travel of the load carrying device at least of 500 mm at any stationary position as well as during the lifting and lowering cycles.

A safety device shall be operated in the event of rupture of the mechanical lifting element which automatically stops the motion.

The safety device shall be independent of the drive system and not be dependent on energizing or maintaining an electrical or other auxiliary circuit.

Vehicle lifts designed to be used over pits or over a lift as a wheel free system shall fulfil this requirement throughout the travel of the load carrying device (refer to Annex C).

In the case of failure of the mechanical lifting element it can be possible to lower the load but restarting the lifting operation from the initial position shall be prevented.

Further requirements on catching devices see 4.18.3.

4.14 Safety against leakage

4.14.1 Limiting the lowering speed

Vehicle lifts with hydraulic or pneumatic drives shall be designed to prevent the load carrying device from lowering faster than 1,5 times the normal lowering speed in the case of leakage in the line (refer to Annex C).

4.14.2 Protection against leakage

Vehicle lifts shall be designed to prevent the load carrying device from moving more than 100 mm in the case of leakage after a vertical travel of the load carrying device at least of 500 mm at any stationary position as well as during the lifting and lowering cycles. Vehicle lifts to be used over pits or over a lift as a wheel free system shall fulfil this requirement throughout the full stroke of the load carrying device (refer to Annex C).

This requirement need not be fulfilled if the lowering speed in case of failure is limited to max 10 mm/s and desynchronization higher than the limit defined in 4.15 is not possible. Catching devices used to achieve this may be released in order to lift or lower the carrying device but shall automatically resume their function after an intentional stop.

It is assumed that no more than one leakage in the circuit is considered at the same time (refer to Annex C).

4.15 Additional requirements for lifts with more than one lifting units

If vehicle lifts are designed to carry the load with more than one lifting unit, one shall ensure that:

a) the load carrying device of each lifting unit is not overloaded when carrying the intended load;

b) carried loads cannot roll, slide, tilt or rotate;

c) unintentional asynchronization is limited within the following constraints:

   1) a difference between the heights of load carrying devices of 50 mm or 1° of tilt in case the difference is more;

   2) an additional 100 mm difference between the heights of the load carrying devices in case of unintended blocking of a load carrying device (4.12), rupture of the driving or control unit, leakage in the hydraulic or pneumatic line, of rupture of ropes, chains, nuts or gears (4.13);

   3) with vehicles having a high torsional rigidity (e.g. rail vehicles) overloading of the lifting unit can occur within the limits mentioned under 1) and 2). Measures shall be taken to prevent overload including any asynchronization caused by the function of safety devices (e.g. over dimensioning or load-limiting device). The correct placing of the load shall be done by the operator and be monitored during lifting and lowering by a load sensing and/or levelling device.

For vehicle lifts mentioned in c3) special attention (negotiation between user and manufacturer) should be given to the maximum values described in 1) and 2).

Safety related parts in the synchronization control system shall comply with performance level c of EN ISO 13849-1:2015.

Any safety related parts of control systems for vehicle lifts mentioned under c3) shall comply with performance level d of EN ISO 13849-1:2015.

In case of failure, procedures shall be provided to ensure restoration of orderly conditions. The correct procedure in case of a stop due to an "out of limits" synchronisation system shall be provided within the complete operation instructions.

4.16 Additional requirements for mobile lifts

4.16.1 Safety against unintended motion

It shall be possible to prevent mobile vehicle lifts from moving inadvertently on level floors and those which slope within the limits stated by the lift manufacturer (refer to Annex C).

Brakes used to fulfil this requirement shall be dimensioned such that they will prevent spontaneous movement of a vehicle lift at rest and loaded with the rated load, on a slope 2° greater than stated as acceptable by the manufacturer.

4.16.2 Service brakes for vehicle lifts using powered mobility

Vehicle lifts which use powered mobility shall be equipped with automatic brakes.

The brakes shall be dimensioned such that they can stop an unloaded vehicle lift running at the maximum speed stated by the manufacturer and on a slope 2° greater than stated as acceptable by the manufacturer.

4.16.3 Devices for moving manually mobile lifts

Suitable hand grips shall be provided on manually mobile lifts where the frame does not afford adequate gripping. Grips shall be designed to prevent hand injury and shall be positioned so that their use does not create a hazard, trapping feet around the frame or wheels of the vehicle lift during movement of the vehicle lift.

4.16.4 Derailment protection

If a vehicle lift is moved on rails, derailment shall be prevented.

4.16.5 Forces

The manual forces at an ambient temperature of (20 ± 5) °C shall not exceed 400 N to start the movement and 300 N to sustain the movement on a flat level floor.

4.16.6 Visibility

The operator's position shall be positioned so that the operator is able to observe the space in the travel direction of the vehicle lift.

4.17 Protection against pinching and shearing

4.17.1 General

Pinching and shearing points shall be made safe by means of sufficient distance between the moving parts or between the moving and stationary parts. If this is not possible other means (see 4.17.3) shall be used so that neither the operator nor bystanders are jeopardised.

Persons standing next to a lift are considered protected from pinching and shearing points between the load carrying device and the ground if coverage is afforded by any vehicle being lifted.

4.17.2 Safety distances

As a minimum the following parts of the human body shall be safeguarded by these minimum distances:

— width of fingers: 25 mm;

— height of feet: 120 mm.

The pinching and shearing points for feet are considered as avoided if a minimum free space for feet is maintained in accordance with Figure 11.

Dimensions in millimetres

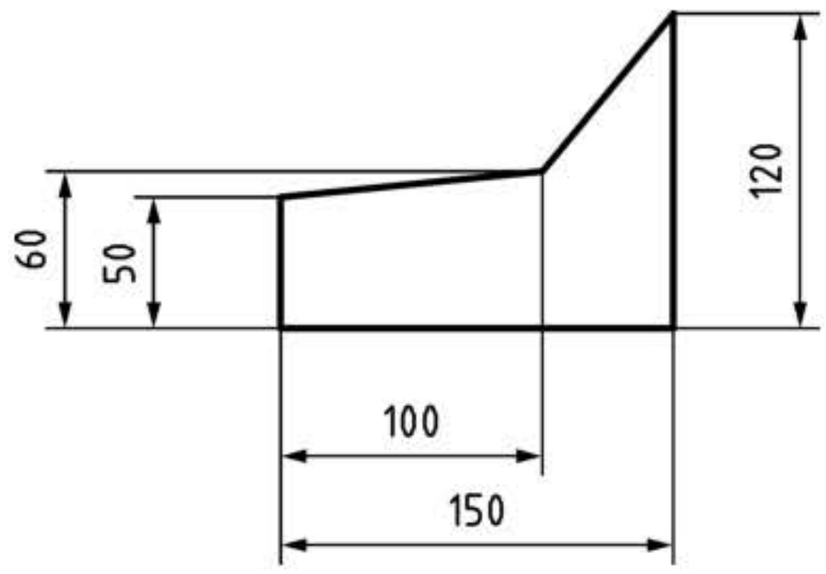


Figure 11 — Clearance for feet

Exceptions are permitted for drive on ramps which are mounted in such a way that the vertical squeezing forces are restricted to not more than 250 N.

4.17.3 Other safety measures

For places where the specified distances cannot be observed, guards such as covers or rails shall be used to prevent access to the dangerous areas or other devices shall be used which stop the movement of the lift if an object or part of the body is placed in its path. In all cases these devices shall not give rise to any additional hazards.

Covers or rails may be constructed from rigid or flexible materials. Rigid materials shall be dimensioned so as to withstand any load to which they are likely to be subjected without permanent deformation. Flexible materials shall be robust enough not to be damaged during their use.

Protective equipment which stops the movement of the lift (e.g. pressure sensitive edges/bars according to EN ISO 13856-2:2013) shall do so before a dangerous situation arises.

The requirement for protection of feet is also satisfied if, during the lowering of the lift, the movement is automatically halted at a distance of 120 mm before the dangerous position. The movement may then be restarted by operation of an additional lowering control or by releasing and reactivating the normal lowering control. This final portion of the travel shall be accompanied by an audible warning. In either case it shall not be possible to override the stopping device such that the lift travels to its initial position without stopping.

For wheel free systems the requirement for protection against pinching and shearing is satisfied:

— if there exists a safety distance of at least 25 mm between any pinching and shearing points of the load carrying devices when operating the controls for lowering, an acoustic signal is automatically activated which sounds during the whole lowering movement;

— if there exists no safety distance between any pinching and shearing points of the load carrying devices then, when operating the controls for lowering, an acoustic signal is automatically activated two seconds before the movement starts and continues throughout the whole of the lowering movement.

When it is foreseen (e.g. maintenance) that the aforementioned fixed guards will be removed regularly then the fastenings shall remain attached to the guards or to the vehicle lift.

4.18 Safety devices

4.18.1 General

Safety devices for vehicle lifts are emergency stop devices (see 4.4.4), devices to prevent inadvertent motion (see 4.8.1), pressure relief valves (see 4.8.4.2 and 4.8.5.3), arm locking systems (see 4.9.4), roll-off safety devices (see 4.9.5), catching devices (see 4.13), unloaded accompanying bearing devices (see 4.13), safety means in the event of hose and pipe damage (see 4.14), means to prevent pinching and shearing (see 4.17.3) and safety switches (see 4.18.4).

4.18.2 Arrangement

Safety devices shall be designed and arranged so that they are protected against unauthorised or inadvertent adjustment or damage.

4.18.3 Function of mechanical safety devices

Mechanical safety devices shall operate by using mechanically interlocking parts and not rely on friction. Catching devices shall automatically engage with an interlocking and holding function to prevent uncontrolled descent.

4.18.4 Safety switches

Safety switches shall fulfil the requirements of EN 60947-5-1:2017.

Safety switches in lifts are, for example, switches that will stop the drive in the event of inadvertent blocking of the load carrying devices, or switches in switch-off elements that protect pinching and shearing points. In this instance, only the current motion shall be stopped, and the reverse motion may be still possible.

Safety switches which control failure are, for example, emergency limit switches, wire rope, chain, nut, or gear rupture switches, or levelling control switches. After being operated, those switches shall prevent normal further operation of the lift (refer to Annex C).

Safety switches shall operate such that safety devices are activated by cutting off the power.

4.18.5 Springs in safety devices

Failure of a spring shall not make safety devices inoperative (refer to Annex C). Furthermore, compression springs shall be guided to prevent them buckling or the ends becoming displaced during use.

4.19 Protection against damage

4.19.1 Wearing parts

It shall be possible to inspect wire ropes, chains and screws over their whole length without difficulty for maintenance and examination. Thread wear on the lifting nut shall be measurable without difficulty, for example, by careful measurement of the distance between the lifting nut and the unloaded safety nut. If necessary, inspection holes shall be provided.

4.19.2 Lead screws

Lead screws in screw drives shall be protected from damage and dirt.

4.19.3 Installation of hoses, pipes and electrical equipment

Hoses, pipes and electrical equipment shall be installed such that they will not be damaged during the movement of loads or part of the machinery.

4.20 Manually driven vehicle lifts

Control mechanisms of manually driven vehicle lifts shall be equipped in such a way that:

a) winding handles, levers or wheels cannot turn back under load more than 15 cm, measured at the greatest radius of the control (reversal security). Reversal security shall not be necessary for hand-wheels if these take the form of complete smooth disc wheels imperforate and without any other handles;

b) the direction of rotation of winding handles remains the same regardless of gearing; and

c) removable winding handles, levers, and hand wheels shall be secured against slipping and unintentional removal from the drive shaft (refer to Annex C).

The driving force on the provided handle measured at the end of it at the rated load at an ambient temperature of (20 ± 5) °C shall not exceed 400 N when driven according to the manufacturer's specification.

4.21 Electrical equipment

4.21.1 General

All parts of electrical equipment shall meet the requirements of the relevant CENELEC-Standards, especially EN 60204-1:2018.

4.21.2 IP-code

The IP-code of the control box and of switches according to EN 60529:1991[1] shall be at least IP 54 to use the fault exclusions regarding “Short circuits between two adjacent tracks/pads” (see EN ISO 13849-2:2012, Table D.5). Components in systems less than 48 V shall comply with EN 60204-1:2018.

If the vehicle lift is intended for outdoor use, the IP-code 54 is valid for all electrical components of the lift exposed to the outdoor conditions.

4.21.3 Means of disconnecting the power supply

Vehicle lifts with electrical power supply shall be equipped with a device that allows the power supply to be disconnected (see EN 60204-1:2018). Deviation from 5.3.3 of EN 60204-1:2018, a switch with two

On-positions (usually known as command positions) which controls the up and down movement is permissible if it fulfils all other requirements on a main switch according to EN 60204-1:2018.

4.21.4 Batteries

Batteries shall be secured in position and be protected against external effects such as vibrations, water, high pressure cleaning, etc.

4.22 Special requirements for vehicle lifts where it is permitted to stand under the load during lifting and lowering movement

4.22.1 Control devices

To avoid unintentional movements in case of a failure, the control circuits for lifting and lowering movement as well as the emergency stop function shall comply with performance level d of EN ISO 13849-1:2015. All relevant failures listed in EN ISO 13849-2:2012 shall be considered.

4.22.2 Control positions

Control positions shall be located such that persons standing under the vehicle are in a direct field of vision of the operator at the control devices. Direct speech communication shall be possible. If necessary, an additional control position shall be provided. If remote control is activated all other control stations – except the emergency stop controls and an eventual consensus control device - shall be deactivated.

If the vehicle lift is fitted with a mobile control (wired or wireless) which can be used from a position under the load, a consensus control device at a fixed position outside of the hazardous area shall be provided. From the position of the switch, the operator shall have a direct view of any persons under the load. The consensus control device shall be of the hold-to-run type.

4.22.3 Lifting and lowering speed

The maximum speed for lifting and lowering shall not exceed 0,005 m/s for rail-bound vehicles and 0,01 m/s for road and special vehicles.

4.22.4 Safety against rupture or leakage of load bearing devices

Vehicle lifts shall be equipped with a catching device preventing unintentional lowering of more than 20 mm in case of rupture of ropes, chains, carrying nuts or gears or leakage in the hydraulic or pneumatic system. This device shall be effective during lifting and lowering movements as well as when the raised load is static.

4.22.5 Operation instructions

The operation procedure in the case of a person standing below moving loads shall be described precisely in the operation instructions. At least two persons are required for this mode of operation (operator and worker under the load).

4.23 Additional requirements for vehicle lifts for motorcycles

On vehicle lifts for motorcycles the following additional requirements apply:

1) For calculation of the load carrying device, the load of the normative vehicle a) of Table 3 shall also be regarded acting in only one small area (motorcycle on a stand) 200 x 200 mm.

2) The load carrying device shall be fitted with a holding device to prevent the motorcycle from falling. The device shall guarantee vehicle stability in the event of forces applied by the operator (see

4.7.2.1d). It is assumed that they are applied on the vehicle and oriented in the worst condition. The stability of the vehicle shall also be ensured in the event of disassembly of parts of the same (e.g. rear wheel).

3) A vehicle lift can be used also for motorcycles as long as the particular requirements for motorcycle lifts are respected without creating additional risks.

5 Verification of the safety requirements and/or measures

5.1 General

Table 5 indicates the method(s) by which the safety requirements and measures described in Clause 4 shall be verified, together with a reference to the corresponding subclauses in this document.

Table 5 — Means of verification of the safety requirements and measures

Subclause	Safety requirements and measures	Visual inspection	Function test	Measurement
4.2	Preventing unauthorised operation	X		
4.3.1	Hold-to-run control	X		
4.3.2	Grouped control devices	X		
4.3.3	Logical operation	X	X	
4.3.4	Marking	X		
4.3.5	Unintentional operation	X	X	
4.4.1	General requirements on controls	X	X	
4.4.2	Fixed controls	X		X
4.4.3	Mobile controls		X	
4.4.4	Controlling multiple Lifting Units Lift	X	X	
4.4.5	Emergency stop device	X	X	
4.4.6	Stopping device	X	X	
4.5	Duplicated drive systems		X	
4.6	Speeds			X
4.7–4.7.4.5	Structural design of the supporting structure	X	X	X
4.7.5.1	Catching devices and mechanical re-raising prevention devices	X	X	
4.7.5.2	Rope drives	X		
4.7.5.3	Chain drives	X		
4.7.5.4	Hydraulic and pneumatic drives	X	X	
4.7.5.5	Screw-drives	X	X	

Subclause	Safety requirements and measures	Visual inspection	Function test	Measurement
4.7.5.6	Mechanical connections of several lifting units	X	X	
4.7.6	Proof of stability against overturning	X	X	
4.8.1	Preventing uncontrolled motion		X	X
4.8.2	Preventing inadvertent moving from stationary condition when raised	X	X	
4.8.3.1	Derailment protection	X		
4.8.3.2	Safety at nip points	X	X	
4.8.3.3	Tension regulation	X		
4.8.4.1	General requirements for hydraulic drives	X	X	X
4.8.4.2	Pressure relief valve	X	X	
4.8.4.3	Bleeding	X		
4.8.4.4	Connection for pressure gauge	X		
4.8.4.5	Filter	X		
4.8.4.6	Fluid level control	X		
4.8.4.7	Size of the fluid tank	X		X
4.8.4.8	Gas loaded accumulator		X	
4.8.5.1	General requirements for pneumatic drives	X	X	X
4.8.5.2	Holding device	X	X	
4.8.5.3	Pressure relief valve	X	X	
4.8.5.4	Pressure reduction	X		
4.8.5.5	Hot working	X		
4.8.5.6	Use in low temperatures	X	X	
4.8.5.7	Moisture reduction	X		
4.9.1	Unintended motion of the load carrying device	X		
4.9.2	Vehicle pick-up-plates	X	X	X
4.9.3	Vehicle pick-up pads	X	X	X
4.9.4	Locking systems of carrying arms	X	X	X
4.9.5	Prevention of rolling off	X	X	X
4.10	Additional requirements for lifts with balconies	X	X	X
4.11	Limiting the travel of the load carrying device	X	X	

Subclause	Safety requirements and measures	Visual inspection	Function test	Measurement
4.12	Unintended blocking of the load carrying device		X	
4.13	Safety against rupture of mechanical lifting elements	X	X	X
4.14.1	Limiting the lowering speed		X	X
4.14.2	Protection against leakage		X	X
4.15	Additional requirements for lifts with more than one lifting units		X	X
4.16.1	Safety against unintended motion		X	
4.16.2	Service brakes for vehicle lifts using powered mobility		X	
4.16.3	Devices for moving manually mobile lifts	X		
4.16.4	Derailment protection	X	X	
4.16.5	Forces			X
4.16.6	Visibility	X		
4.17.1	General requirements against pinching and shearing	X		
4.17.2	Safety distances			X
4.17.3	Other safety measures	X	X	X
4.18.2	Arrangement of safety devices	X		
4.18.3	Function of mechanical safety devices	X		
4.18.4	Safety switches	X	X	
4.18.5	Springs in safety devices	X		
4.19.1	Wearing parts	X		
4.19.2	Lead screws	X		
4.19.3	Installation of hoses, pipes and electrical equipment	X	X	
4.20	Manually driven vehicle lifts	X	X	X
4.21.1	General requirements on electrical equipment	X		
4.21.2	IP-code	X		X
4.21.3	Means of disconnecting the power supply	X		
4.21.4	Batteries	X		
4.22.1	Control devices	X	X	

Subclause	Safety requirements and measures	Visual inspection	Function test	Measurement
4.22.2	Control positions	X		
4.22.3	Lifting and lowering speed			X
4.22.4	Safety against rupture or leakage of load bearing devices	X	X	
4.22.5	Operation instructions	X		
4.23	Additional requirements for vehicle lifts for motorcycles	X	X	
6.1	General requirements on the information for use	X		
6.2	Marking	X		
6.3.1	Complete operation instructions	X		
6.3.2	Digest of the instructions for use	X		
6.4	Name plate	X		

5.2 Introduction

The tests given in this verification chapter shall be used to verify the compliance of vehicle lifts and their components with this document. These tests shall be carried out on at least one sample of each model type.

The test to ensure that the vehicle lift complies with this document shall consist of:

a) design check (see 5.3);

b) manufacturing check (see 5.4);

c) visual verification (see 5.5);

d) practical tests (see 5.6).

The results of examinations, visual inspections, function tests and measurements shall be recorded in a signed report along with the name and address of person(s) and firm making them.

5.3 Design check

The design check shall verify that the vehicle lift is designed in accordance with this document. It shall be checked that:

a) drawings contain the main dimensions of the vehicle lift;

b) there is a description of the vehicle lift with necessary information about its capabilities;

c) there is information about the materials and components used;

d) there are diagrams of the electrical, hydraulic and pneumatic circuits;

e) there are instructions covering installation, commissioning, operating, maintenance and dismantling.

The documents shall give all necessary information to enable:

f) the structural calculations to be checked;

g) the stability calculations to be checked.

5.4 Manufacturing check

The manufacturing check shall verify that:

a) the vehicle lift is manufactured in accordance with the checked documents, with special attention to safety devices;

b) the test certificates are available for ropes, chains and hoses;

c) welding has been performed according to the drawing specification.

5.5 Visual verification

It shall be verified that:

a) all markings defined in 6.2, 6.3.2 and 6.4 are attached to the vehicle lift;

b) the vehicle lift is in accordance with all documentation provided by the manufacturer.

5.6 Practical tests

5.6.1 General

Practical tests shall be made to verify that:

a) the vehicle lift is stable;

b) the vehicle lift is structurally sound;

c) all functions work correctly and safely.

5.6.2 Overload dynamic test

The test load shall be 115 % of the rated load.

The load distribution shall be made in accordance with 4.7.4.

All movements with the test load shall be carried out at appropriate accelerations and decelerations with safe control of the load. The intended movements shall be carried out with care, taking into due account the least favourable positions and when vibrations associated with preceding movements have subsided.

When, due to various combinations of load distributions of a vehicle lift, tests with different test loads are necessary, all movements shall be carried out with all test loads except where the least favourable conditions can be simulated by one performance test. During this test the vehicle lift shall be capable of stopping and sustaining the test load(s).

5.6.3 Overload static test

The test load shall be 150 % of the rated load. The load distribution shall be made in accordance with 4.7.4.

During any overload static test, the vehicle lift shall be put into each position which creates maximum stress in any load carrying device or supporting structure of the lift.

After removing the test load(s) the vehicle lift shall show no permanent deformation.

5.6.4 Functional tests

a) With rated load

Functional tests with rated load shall demonstrate that:

1) the vehicle lift can be operated smoothly for all motions at the rated speed;

2) the safety devices work correctly. This included the protection against leakage (see 4.14.2), which shall be tested with 40 % and 100 % of the rated load;

3) the levelling devices work within stipulated differences (see 4.15);

4) maximum permitted speeds are not exceeded.

b) Without load

A functional test without a load shall demonstrate that the arm locking system resists the stipulated values (see 4.9.5).

5.6.5 Electrical tests

Electrical tests shall be performed according to EN 60204-1:2018.

6 Information for use

6.1 General

Information for use may consist of text, words, signs, signals or diagrams, used separately or in combination. It is directed to the installer and the user.

The information of use is an integral part of the supply of the vehicle lift.

This information shall comply with EN ISO 12100:2010, 6.4 and with the following provisions.

6.2 Marking

The following information shall be fixed on the lift and shall be readily visible:

a) the rated load in kilograms or tonnes;

b) the allowable load distribution if the rated load depends on it;

c) only on vehicle lifts for normative vehicles according to 4.7.4.2 or 4.7.4.3 with load sensing or load moment sensing devices, the maximum capacity of an evenly distributed load;

d) the unladen weight in kilograms or tonnes if the lift is mobile;

e) a warning sign “travelling on the load carrying devices is forbidden” if the lift is not designed for this purpose;

f) hydraulic supply information if an external hydraulic power supply is used;

g) pneumatic supply information if an external pneumatic power supply is used;

h) electrical supply information if an external electric power supply is used;

i) if the vehicle lift is designed for outside use, specific information about safe use of the lift when exposed to wind effect, in which the maximum allowed wind speed exposure for each type of normative vehicle is shown (refer to Annex D).

6.3 Operation instructions

6.3.1 Complete instructions

A complete operation manual containing the information for safe use and operation of the lift shall be supplied with each lift.

It is acceptable if the complete operation manual is available in electronical format only. If required by the user, it shall be supplied in paper form.

This manual shall include at least the following information:

a) name and address of manufacturer, importer or dealer;

b) range of application (use, misuse);

c) type of vehicle support the lift was designed for (wheel support/chassis support/chassis and wheel support), followed by a statement that the lift has to be used only referring to the type of vehicle support specified by the manufacturer;

d) a statement that a general evaluation of the residual life-time is to be done at latest 10 years of employ by a qualified technician, preferably authorized by the manufacturer;

e) use of accessories for the vehicle lift, e.g. rolling jack;

f) data about acceptable pit jacks/rolling jacks or other additional interchangeable equipment (e.g. capacity);

g) installation and commissioning;

h) handling and behaviour while operating the lift;

i) monitoring of the safety devices;

j) maintenance and frequency of maintenance;

k) list of necessary safety checks and periods not exceeding one year as long as national laws or operational or environmental circumstances do not require shorter check intervals;

l) inspection; (including test procedure for the maximum allowable free play on carrying arms);

m) trouble shooting;

n) replacement of parts, e.g. due to wear or operation of safety devices;

o) if applicable, charging of batteries and ventilation of the room;

p) the vehicle lift shall be operated with respect to the complete operating instructions;

q) only authorized persons shall operate the lift;

r) activation of hand brake and use of chocks to prevent vehicles from rolling on platforms;

s) in the case of a multiple lifting unit lift, the lifting capacity of each lifting unit and guidance on safe combined rated loads shall be provided;

t) in case that persons are permitted to stand under the vehicle during lifting and lowering:

1) special training has to be given to the operator and the persons who are permitted to stand under the vehicle during lifting and lowering;

2) during normal operation, no persons are permitted to stand under the vehicle;

3) persons are only permitted to stand under the moving load in extreme circumstances where movements of the load should be kept as short as possible;

u) the additional consensus control device(s), if appropriate, shall be located in such a way that from these locations together with the normal operating position the whole hazardous area can be monitored;

v) maximum permissible wind speed according to 4.7.2.2 and 4.7.2.3, if appropriate. The need to lower the raised vehicle in the nearest position to the ground level if the maximum permissible wind speed is exceeded and at the end of working time;

w) advice for the user to perform special hazard analyses when entering a lifted vehicle or using the vehicle lift for PTI and to use special means for access into the lifted vehicle;

x) when lifting a vehicle with a multiple lifting unit lift it shall be ensured that:

1) the operator shall make the appropriate choice in relation to the lift/vehicle combination by evaluating the axles on which to apply each independent lifting unit in order to avoid overloading or damage to the vehicle itself;

2) the maximum wheel load does not exceed the lifting capacity of each independent lifting unit and that the maximum axle load of the vehicle does not exceed the lifting capacity of two independent lifting units supporting the axle;

NOTE The axle load of the vehicle can be not equally distributed to the wheels.

3) the operator shall be aware that the rated load of the multiple lifting unit lift may not correspond to the sum of the lifting capacities of the individual lifting units;

y) information about noise;

z) information for the installer, that after installation the name plate shall remain readily visible.

In cases f), i) and k) the information shall also include necessary information concerning the strength of foundations and necessary inspection traps in the floor.

In the event of the vehicle lift being first assembled at the user's site, the operation instructions shall contain a statement that it shall be checked that the vehicle lift and the associated safety and protective

devices are correctly installed and function in a proper manner. The procedure shall be written in the operation manual.

6.3.2 Digest of the instructions for use

A digest of the instructions for use containing at least the following information taking into account possible hazards existing for the lift where applicable for the safe operation shall be fixed on the lift and shall be readily visible.

a) The operation of the lift is permitted by authorized persons only.

b) It is necessary to refer to the complete operation instructions, especially for trouble shooting.

c) Mobile lifts shall be prevented from moving unintentionally.

d) The field of motion of the load and of the load carrying devices shall be free of obstructions.

e) The operator's attention shall be drawn to the safe method of carrying the load and to the rule that, after raising a short distance, the vehicle shall be checked to ensure that it is correctly and safely positioned.

f) The operator's attention shall be drawn to the rule that the load carrying device shall be observed by the operator throughout the motion of the lift.

g) It is forbidden for people to stand in the field of motion of the load and the load carrying device during the movement, if appropriate.

h) It is forbidden to climb onto the load or load carrying device when they are raised unless via a specifically designed access.

i) What the maximum permissible wind speed is, according to 4.7.2.2 and 4.7.2.3, if appropriate. The need to lower the raised vehicle in the nearest position to the ground level if the maximum permissible wind speed is exceeded and at the end of working time.

j) Specifics instructions according to 4.22:

   1) Stabilize all movable parts of vehicle before staying under the load during lifting/lowering movement;

   2) Wear appropriate Personal Protection Equipment (safety helmet, eyes protector, safety gloves…).

6.4 Name plate

A durable name plate with following information shall be permanently fixed on the lift (refer to Annex C) and shall be readily visible:

a) business name and full address of the manufacturer and, where applicable, his authorized representative;

b) designation of the machinery;

c) designation of series or type;

d) serial number;

e) year of construction, that is the year in which the manufacturing process is completed.

Annex A
(informative)

List of significant hazards

Table A.1 contains a list of hazards which are applicable in the situations described and could involve risks to persons if not reduced or eliminated. The corresponding requirements are designed to limit the risk or reduce these hazards in each situation.

"Not applicable" in Table A.1 means that this hazard does not exist on vehicle lifts.

"Not significant" in Table A.1 means that this hazard can exist on vehicle lifts, but it causes no risk to persons.

Table A.1 — List of significant hazards

Significant hazards		Relevant clauses in this document
1	**Mechanical hazards**	**4.7, 4.8, 4.9, 4.17, 4.22**
1.1	Due to machine parts or workpieces, e.g. by potential energy (falling objects, height from the ground, gravity)	4.12, 4.13, 4.14
	by mechanical strength (break-up)	4.7
1.2	Crushing	4.3.1, 4.6, 4.17, 4.22
1.3	Shearing	4.3.1, 4.6, 4.17, 4.22
1.4	Entanglement	4.8.3.2
1.5	Drawing-in or trapping	4.8.3.2
1.6	Impact	4.5, 4.12, 4.13, 4.14
1.7	Injection	4.8.4.2, 4.19.3
1.8	Slipping, tripping and falling	4.10
1.9	Instability	4.7.6
2	**Electrical hazards**	4.21
2.1	Touching live parts	4.21.1, 4.21.3
2.2	Parts which have become live under fault conditions	4.21.1
3	**Ergonomic hazards**	**4.4, 4.4.2, 4.16.3**
3.1	Unhealthy postures or excessive efforts	4.4.2, 4.16.5, 4.20
3.2	Inadequate consideration of anatomy	4.4.2
3.3	Inadequate local lighting	Introduction
3.4	Design, location or identification of control devices	4.4.2
3.5	Human error during operation	4.2, 4.3, 4.4

Significant hazards		Relevant clauses in this document
4	**Hazards associated with the environment in which the machine is used**	
4.1	Snow, water, wind, temperature	4.7.2.2, 4.7.2.3
5	**Hazards that lead to malfunctions, e.g. unexpected start-up, unexpected overspeeding/spin-out**	
5.1	Failure/disorder of the control system and control circuits	4.3.1, 4.4.3, 4.4.5, 4.4.6, 4.22.1, Annex F
5.2	Restoration of energy supply after an interruption	4.3.1, 4.22.1
5.3	Software error	4.3.1, 4.4.5, 4.22.1
6	**Hazards related to travelling function**	
6.1	Movement when starting the engine	4.16.1, 4.16.2
6.2	Insufficient ability of machinery to be slowed down, stopped and immobilized	4.16.1, 4.16.2
7	**Hazards due to the control system**	
7.1	Inadequate location of manual controls	4.4, 4.4.2, 4.4.3
8	**Hazards from/to third persons**	
8.1	Unauthorized start-up/use	4.3.1, 4.4.2
9	**Mechanical hazards caused by load falls, collisions, machine tipping**	
9.1	Lack of stability	4.7.6
9.2	Unexpected/unintended movement of loads	4.9.5
9.3	Derailment	4.11
9.4	Insufficient mechanical strength of parts	4.7
9.5	Inadequate design of pulleys and drums	4.8.3.1
9.6	Inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine	4.7.5.2, 4.7.5.3, 4.7.5.4, 4.7.5.5

Annex B
(informative)

Structural calculations

B.1 Permissible stresses

B.1.1 General

Symbols

$fy\left(R_{\mathrm{EH}}\right)$	$\left[N / mm^2\right]$	*Yield strength*
$fu\left(R_{\mathrm{m}}\right)$	$\left[N / mm^2\right]$	*Ultimate strength*
$E = 210\ 000$	$\left[N / mm^2\right]$	*Modulus of elasticity*
$G = \frac{E}{2 \times \left(1 + \nu\right)}$	$\left[N / mm^2\right]$	*Shear modulus*
$\nu = 0,3$		*Poisson's ratio*
δ_5	$\left[\%\right]$	*Elongation at failure on gauge length of five times the diameter of the original cross section*
t	$\left[mm\right]$	*Nominal thickness*

Nominal values of material properties for standardized structural steels (EN 10025-2:2019), see Table B.1.

Table B.1 — Material properties

unit for given values in N/mm²

	Nominal thickness of the element			
	$t \leq 40$ mm		40 mm < $t \leq 80$ mm	
	fy	*fu*	*fy*	*fu*
S 235	235	360	215	360
S 275	275	430	255	410
S 355	355	510	335	470

B.1.2 Standardized structural steels

Permissible stresses

$$\sigma_a = fy/s$$

where

s is the safety factor depending on the load combination A, B or C, as shown in the following Table B.2.

Table B.2 — Permissible stresses

unit for given values in N/mm²

Load combination	A *s* = 1,5			B *s* = 1,33			C *s* = 1,25		
	S 235	S 275	S 355	S 235	S 275	S 355	S 235	S 275	S 355
Basic material and butt joint									
$\sigma_a = \sigma_0$	157	183	237	176	206	266	188	220	284
$\tau_a = \sigma_0 / \sqrt{3}$	90	106	137	102	119	154	109	127	164
Fillet weld									
$\sigma_a = \sigma_0$	157	183	237	176	206	266	188	220	284
$\tau_a = \sigma_0 / \sqrt{2}$	111	130	167	125	146	188	133	156	201

The indicated permissible stresses are valid up to a thickness of 40 mm: in case of greater thickness the corresponding value of *fy* shall be taken into consideration.

In selecting the materials, special requirements shall be taken into account, e.g.:

— weldability;

— use of the appliance in extreme climate zones.

B.1.3 Bolts

a) Bolts

The permissible stresses are derived from X, which is the lower value of *fy* and 0,7 × *fu* (see Table B.3).

$$\sigma_a = X / s \qquad \tau_a = \sigma_a / \sqrt{2}$$

Table B.3 — Permissible stresses for bolts

unit for given values in N/mm²

Load combination	*s*	Grade	4.6	5.6	6.6	6.8	8.8	10.9
		fy	240	300	360	480	640	900
		X	240	300	360	420	560	700
A	1,5	σ_a	160	200	240	280	373	467
		τ_a	113	141	170	198	264	330
B	1,33	σ_a	180	225	270	315	420	525
		τ_a	127	159	191	223	297	371
C	1,25	σ_a	192	240	288	336	448	560
		τ_a	136	170	204	238	317	396

b) Preloaded bolts

Grade 8.8 and 10.9 only

Symbols

A_s	$[mm^2]$	*tensile stress area of bolt*
F_v	$[N]$	*preload*
d	$[mm]$	*bolt diameter*
M_t	$[Nm]$	*tightening*

Bolts used one time $F_v = 0{,}8 \times fy \times A_s$

Bolts used several times $F_v = 0{,}7 \times 0{,}8 \times fy \times A_s$

Tightening $M_t \approx 0{,}18 \times d \times F_v / 1\ 000$

c) Bearing pressure

The permissible bearing pressure σ_L depends on the basic material and is not only valid for bolt connections but also for axles (see Table B.4).

Articulation $\sigma_L = 1{,}3 \times \sigma_o$

Clearance joint $\sigma_L = 1{,}5 \times \sigma_o$

Fitted joint $\sigma_L = 2{,}0 \times \sigma_o$

Table B.4 — Bearing pressure

unit for given values in N/mm²

Load combination	A			B			C		
	S 235	S 275	S 355	S 235	S 275	S 355	S 235	S 275	S 355
Articulation	204	238	308	229	268	346	244	286	369
Clearance joint	235	275	335	264	309	399	282	330	426
Fitted joint	313	367	473	352	412	532	376	440	568

B.1.4 Non-standardized structural steels

Depending on the minimum values of the ultimate strength *fu*, the yield strength *fy* and the elongation at failure δ_5 an ideal yield strength *fyi* is to be defined taking into consideration the following conditions:

a) $fy \le 0,7 \times fu$ $\quad fyi = fy$

b) $510 < fu \le 590$ $\quad \delta_5 \times fu \ge 10\ 800$
$590 < fu$ $\quad \delta_5 \times fu \ge 9\ 800$

If this condition is fulfilled, the following applies:

$$fyi = 0,8 \times fu$$

If this condition is not fulfilled, the following applies:

$$r = \frac{26\ 000 - fu \times \left(6 + \delta_5\right)}{9\ 600}$$

$$1,28 \le r \le 1,44$$

$$fyi = fu / r$$

Based on *fyi,* the permissible stresses shall be calculated with the safety factors s given for general structural steels.

B.1.5 Combines stress

Structural parts and butt joints:

$$\sigma = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x \times \sigma_y + 3 \times \tau^2}$$

Bolts, axles and fillet welds:

$$\sigma = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x \times \sigma_y + 2 \times \tau^2}$$

B.1.6 Elastic stability

a) Crippling

Symbols

λ = *slenderness*
λ' = *specific slenderness*
ω = *crippling factor*

The crippling factor ω is defined in the following way:

$$\lambda' = \lambda \times \sqrt{fy / E} / \pi$$

$$\begin{array}{l} 0 < \lambda' \leq 1,195 \\ 1,195 < \lambda' \leq 3 \end{array}$$

$$\omega = 1 / \left(1 - 0,195 \times \lambda' - 0,185 \times \lambda'^{2,5}\right)$$

$$\omega = 1,465 \times \lambda'^{2}$$

The highest permissible slenderness is $\lambda = 250$.

b) Buckling

The critical buckling stress σ_{vki} is defined in the following way:

$$\sigma_{vki} < 0,7 \times fy \qquad \sigma_{vk} = \sigma_{vki}$$

$$\sigma_{vki} \geq 0,7 \times fy \qquad \sigma_{vk} = fy \times \sqrt[4]{1 - 0,461 / \left(\sigma_{vki} / fy\right)^{1,4}}$$

Annex C
(informative)

Examples of solutions

This annex predominantly comprises solutions describing methods by which the requirements of the normative text can be fulfilled.

To 3.1.1

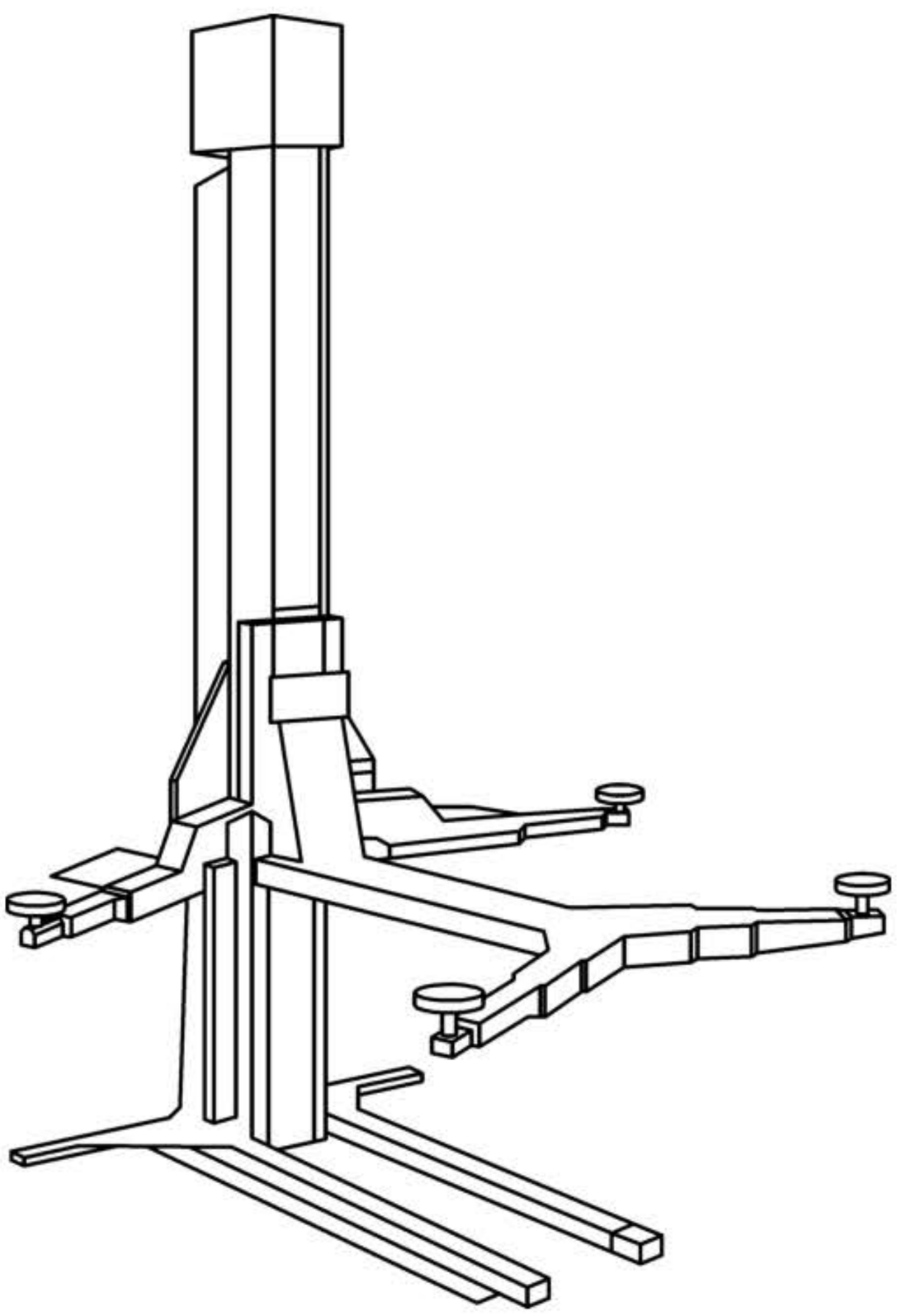
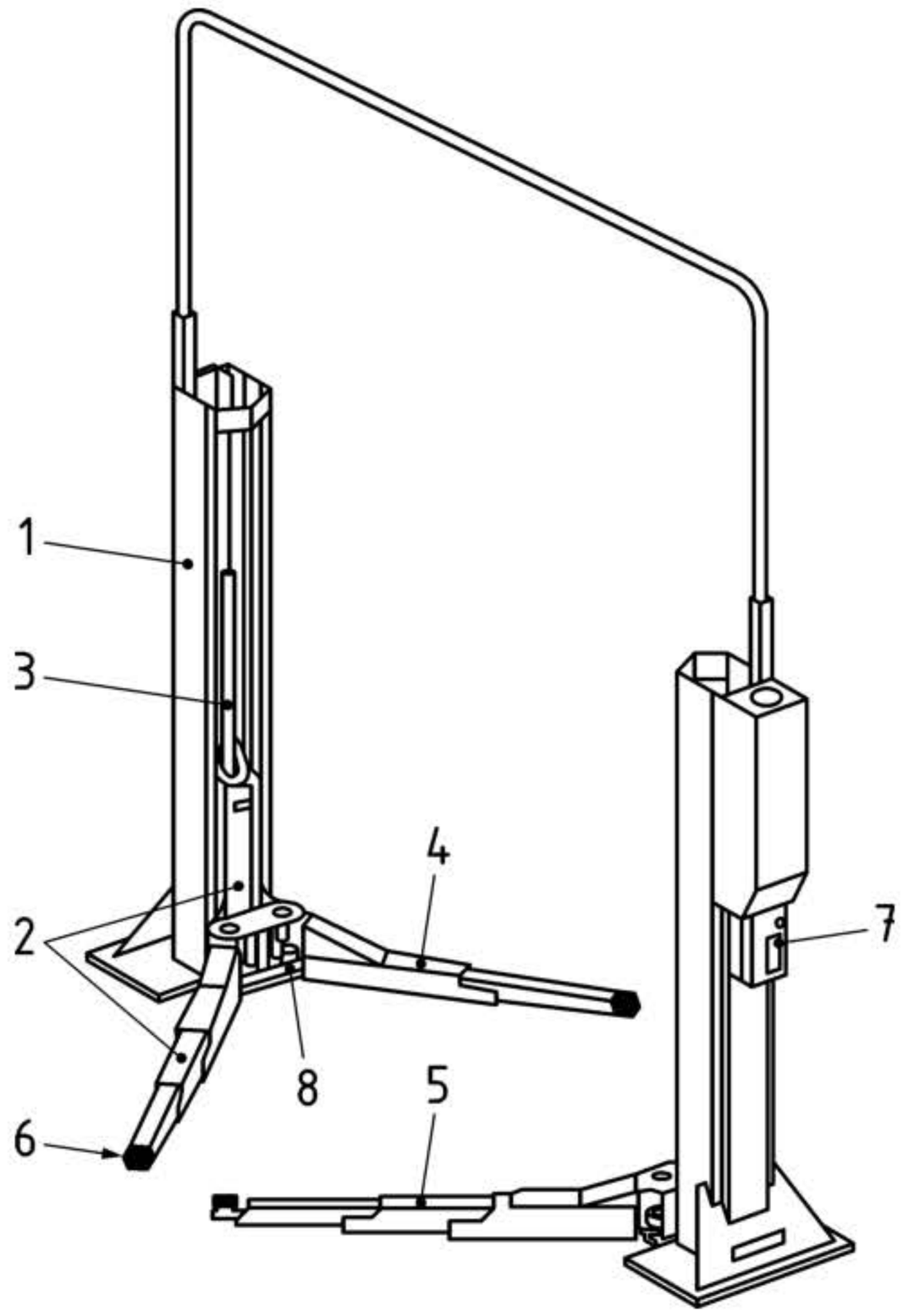


Figure C.1 — Single column lift



Key

1 supporting structure
2 load carrying device
3 lifting element
4 carrying arm (single telescopic)
5 carrying arm (double telescopic)
6 pick-up plate
7 fixed control
8 arm locking system

Figure C.2 — Two column lift

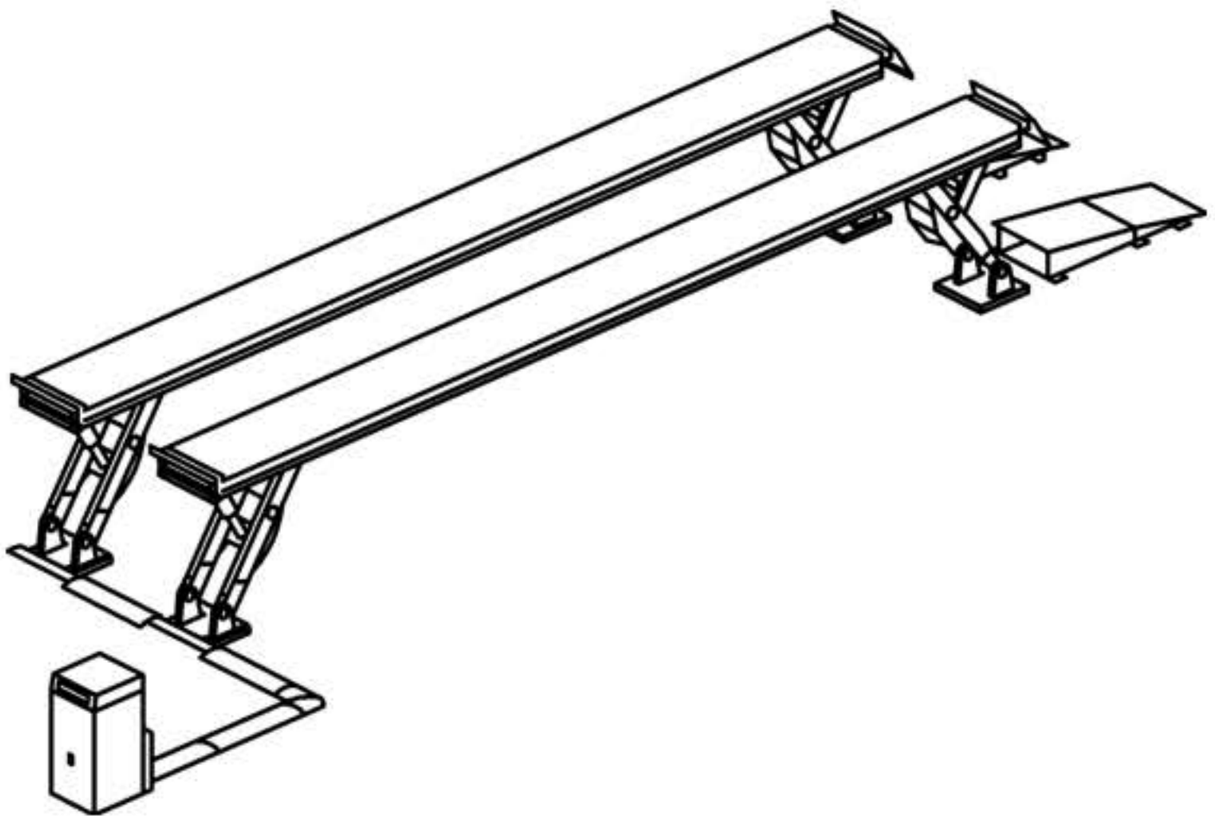


Figure C.3 — Scissor wheel support lift

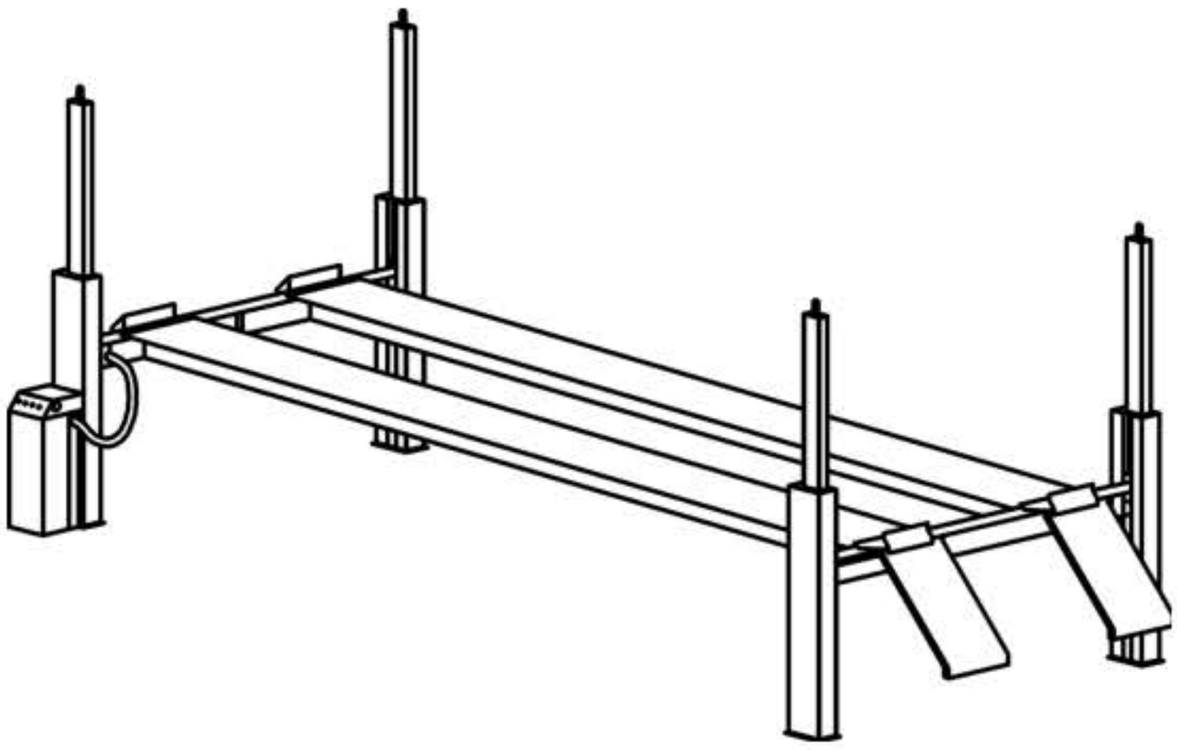


Figure C.4 — Four column lift

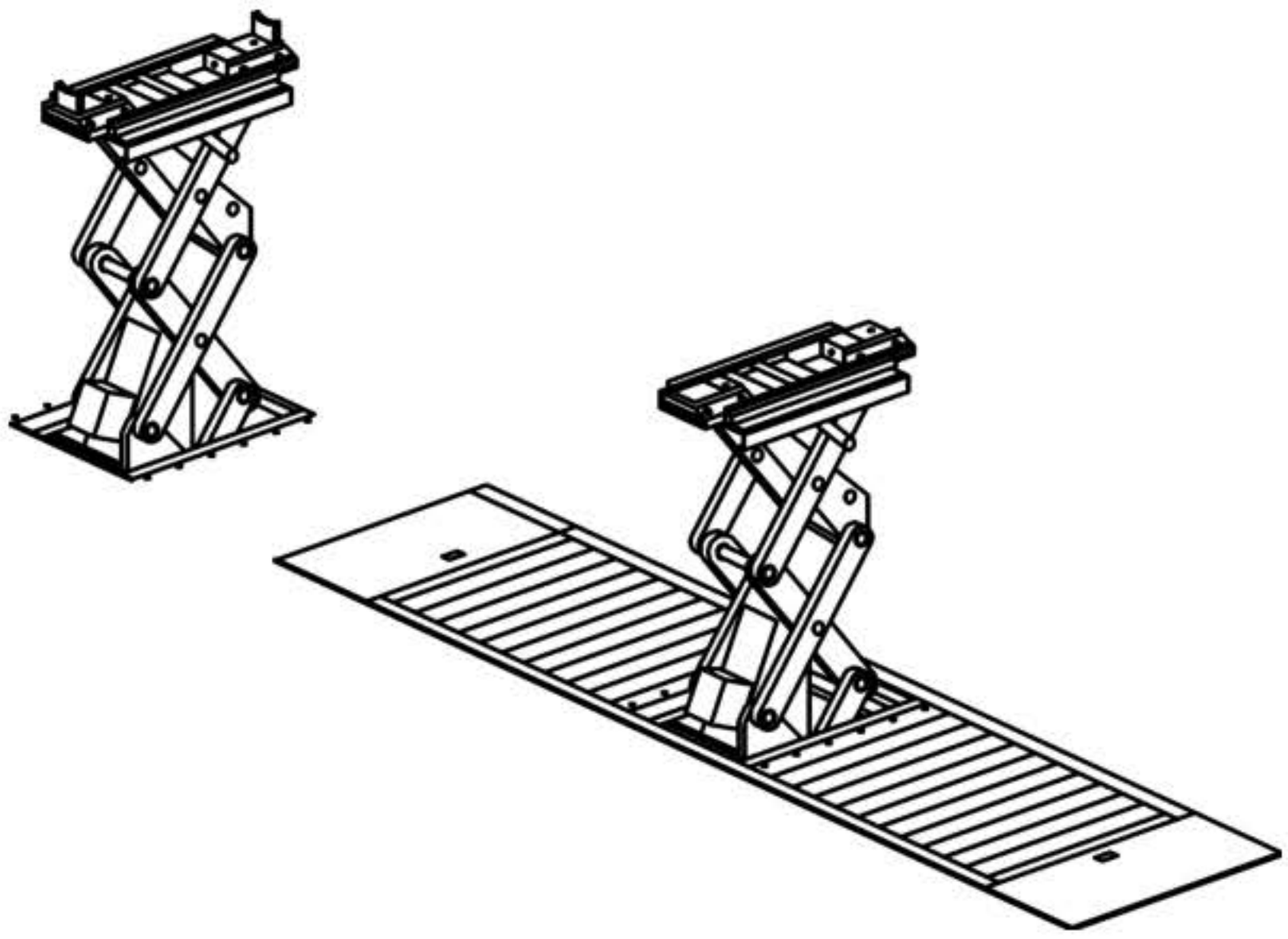


Figure C.5 — Inground scissor

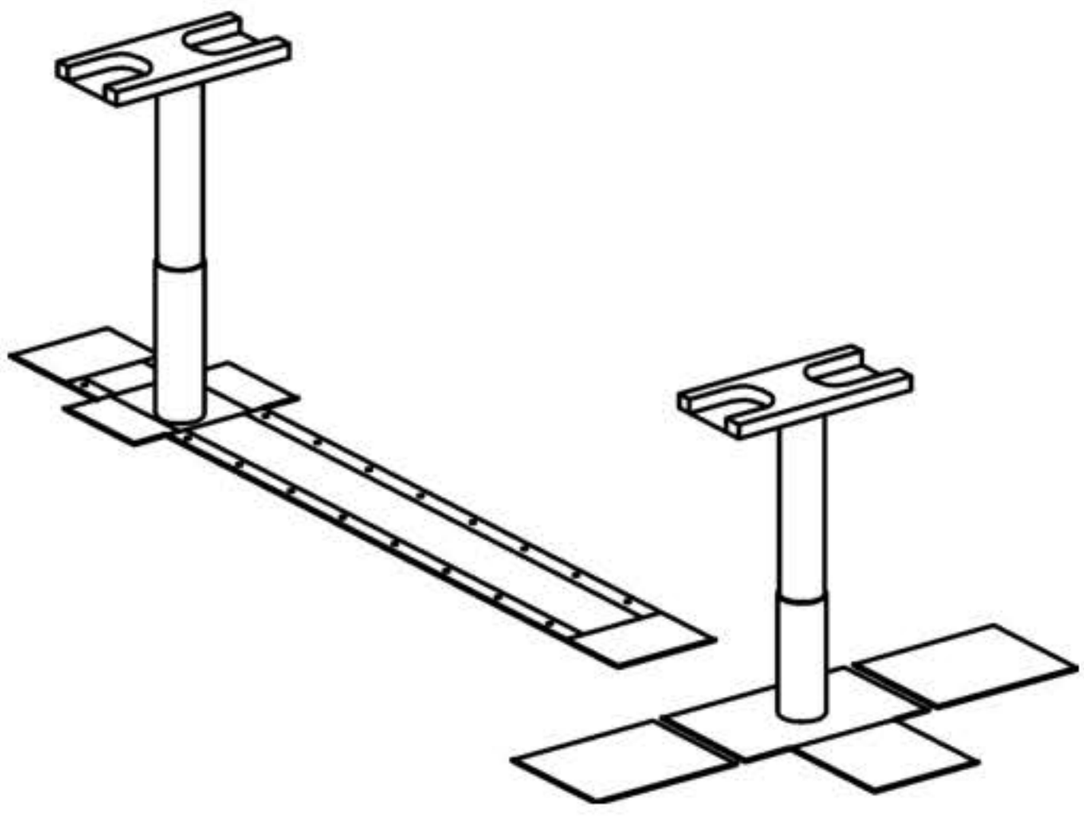


Figure C.6 — Inground piston

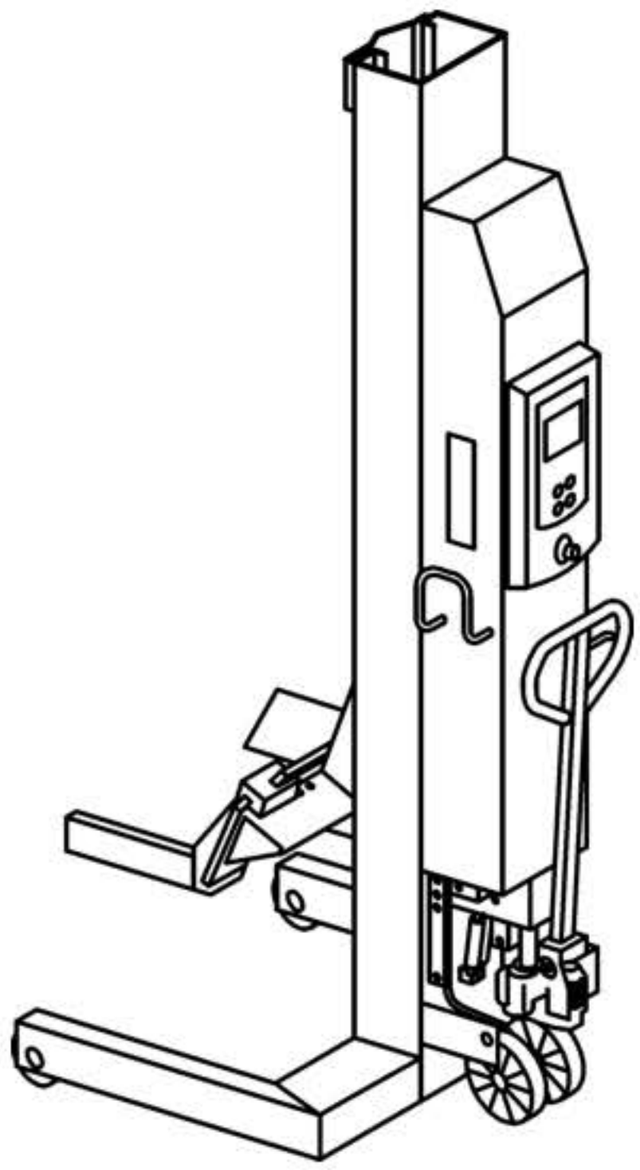


Figure C.7 — Mobile column

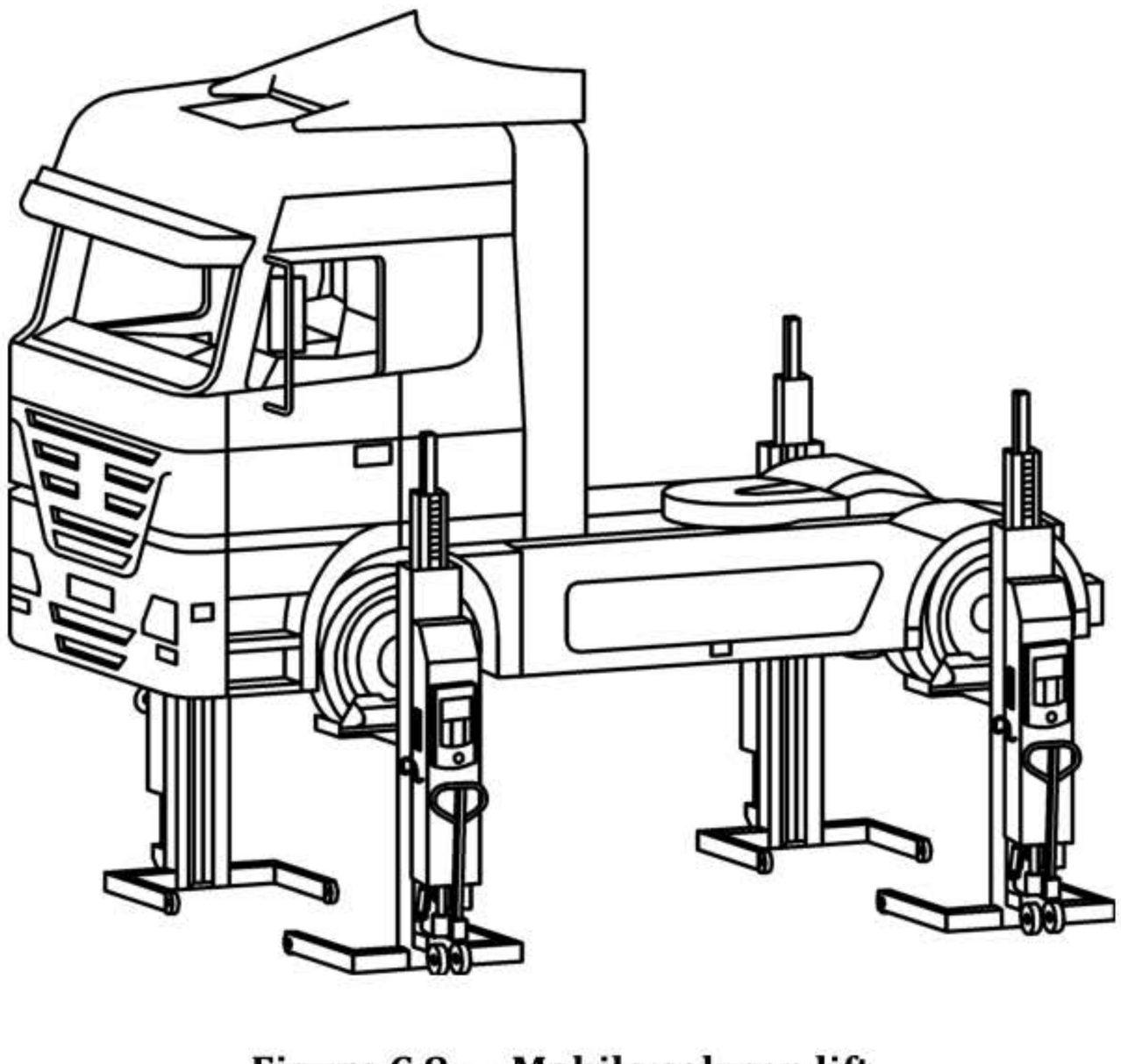


Figure C.8 — Mobile column lift

To 4.2

This requirement can be fulfilled as follows:

a) a switch with a key that can only be taken out after the lift has stopped; or

b) a push-button that locks automatically and can only be released with a security key; or

c) a lockable main switch according to 5.3.2, a), b) or c) of EN 60204-1:2018.

To 4.3.3

For the lifting and lowering operation, this requirement can be fulfilled as follows (see Figures C.9 to C.15):

a) where buttons are used, if the button for the raising movement is positioned above or to the right of the button for the lowering movement (see Figure C.9);

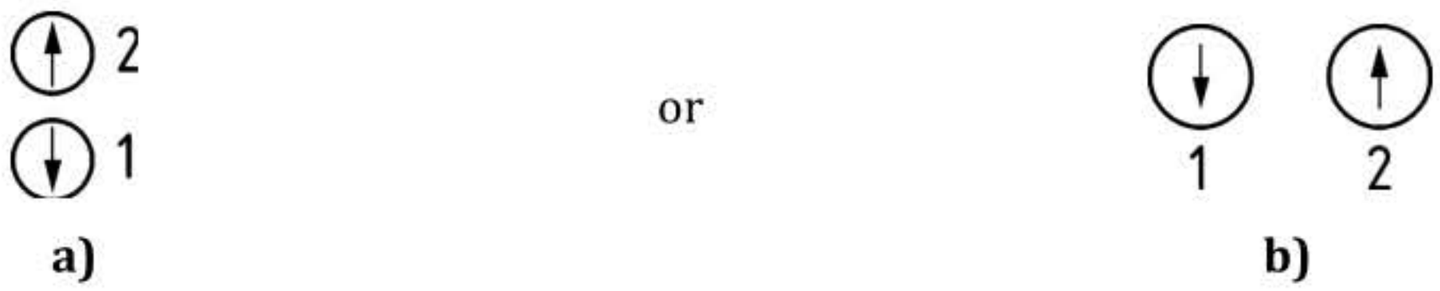
Key

1 down

2 up

Figure C.9 — Arrangement of buttons

b) where foot operated buttons are used, if the button for the raising movement is positioned to the right of the button for the lowering movement (see Figure C.10);



Key

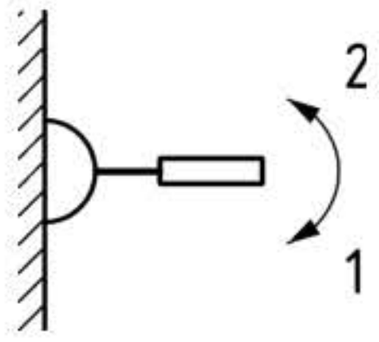
1 down

2 up

Figure C.10 — Arrangement of foot operated buttons

c) where horizontal levers are used:

1) if upward movement of the lever generates the raising movement and the downwards movement of the lever generates the lowering movement (see Figure C.11);

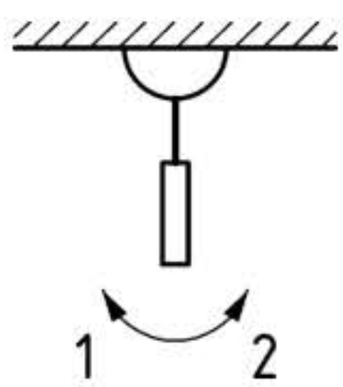


Key

1 down
2 up

Figure C.11 — Up and down movement of horizontal levers (side elevation)

2) if the movement of the lever to the right generates the raising movement and the movement of the lever to the left generates the lowering movement (see Figure C.12);

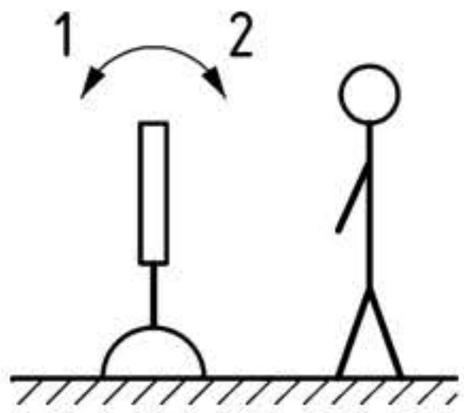


Key

1 down
2 up

Figure C.12 — Left and right movement of horizontal levers (plan view)

d) where vertical levers are used, if the movement of the lever towards the human body generates the raising movement and the movement of the lever away from the human body generates the lowering movement (see Figure C.13);

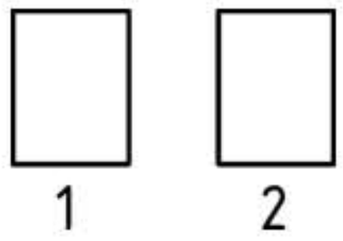


Key

1 down
2 up

Figure C.13 — Movement of vertical levers

e) where pedals are used, if the pedal for the raising movement is on the right and for the lowering movement on the left (see Figure C.14);



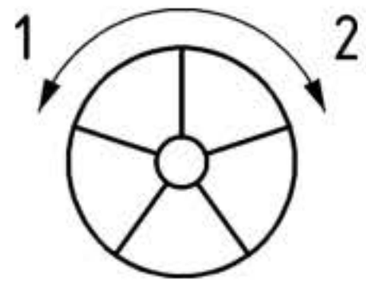
Key

1 down

2 up

Figure C.14 — Arrangement of pedals

f) where hand wheels are used, if turning the wheel clockwise starts the raising movement and turning it anti-clockwise starts the lowering movement (see Figure C.15);



Key

1 down

2 up

Figure C.15 — Movement of hand wheels

To 4.3.4

The requirement "permanently marked" is e.g. fulfilled, if the following test is passed:

Rubbing the marking by hand for 15 s with a piece of cloth soaked with petroleum spirit. After this test the marking shall be easily legible, it should not be easily possible to remove marking plates and they should show no curling.

To 4.3.5

This requirement can be fulfilled as follows:

a) Push buttons: The button shall not be larger than is necessary for it to be operated by one finger of a hand wearing a protective glove. A ring shall surround the button, with minimal clearance, and no part of the button shall protrude above the ring.

b) Foot operated buttons: The space above the button shall be completely covered. The distance between the button and the cover should be approximately 70 mm. A rectangular tubular section approximately 15 mm high should surround the button to protect it from access from the sides (see Figure C.16).

Dimensions in millimetres

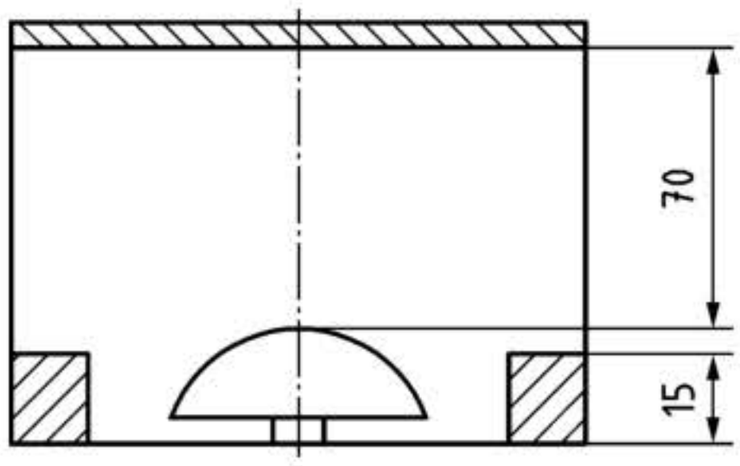


Figure C.16 — Covering of foot operated buttons

c) Hand levers: The lever should automatically lock in its home position.

d) Hand wheels: Shall be round, solid and have no burrs or sharp edges.

If it is necessary to use more than one control device simultaneously to operate the lift then it is sufficient if only one of them is protected against unintentional operation.

To 4.4.2

Examples of further risk:

— Chassis supporting lift: risk of crushing hands of any bystanders not visible to the operator in early lifting movement, during the positioning/adjustment of pick up pads or pick up plates.

— Mobile column lifts, inground truck lifts, rail bound lift: risk of harm to any bystanders not visible to the operator in early lifting movement during the positioning/adjustment of load carrying device, pick up pads, pick up plates.

Examples of suitable control measures to overcome poor visibility in the hazardous area:

— Use of additional remote control:

  • The remote control enables the operator to move position to watch the whole hazardous area.

— Use of mirrors or cameras:

  • These devices should be part of the lift and the responsibility for correct installation is upon the lift manufacturer (or installer) (with agreement from the customer in relation to constraint depending on the installation);

  • The image in the mirrors or in the screen should be clearly visible by the operator at control position.

— One (or more) additional consensus control device located outside the hazardous area so that a second operator (or more) can confirm their safe view of the hazardous area by pushing the buttons.

— Alternative measures that achieve the same level of safety are acceptable.

Examples of suitable control measures that will alert the bystander (and/or co-worker):

— Audible and/or visual warning signal to alert any bystanders that the lift is going to move:

- The audible warning should be at least 75db (A) measured in the hazardous area.
- The visual warning should be an orange beacon flashing light visible in the hazardous area.
- As soon as the lifting button is pressed the audible/visual warning signal is activated. After 2 s the lifting movement should start and the warning signal will stop.
- In order avoid the actuation of audible/visual warning signal at every restart, the signals should be limited to operating only in the first 500 mm of vertical stroke.
- In the case of long lifting systems these warning signals shall be in quantity and positions so that they are perceived by the operator at the control position and by any bystanders (and /or co-workers) in any part of the hazardous area.
- Alternative measures that achieve the same level of safety are acceptable.

To 4.4.3

Listed below are some of the various possible uses of mobile controls (wireless or wired) and, depending upon type, are examples of the safety principles required to avoid additional hazards or foreseeable misuse:

— The remote control is used to let the operator operate the lift from a safe position (outside the hazardous area) that can enable him to monitor the hazardous area.

- The command is active for the complete stroke (lifting and lowering).
- To ensure that the operator cannot operate the lift when standing under the lifted vehicle, one or more additional consensus control devices (hold to run type) should be present, fixed outside the hazardous area to be operated by the operator himself.
- The second operator is not needed and the requirements of 4.22 do not need to be fulfilled.

— For mobile column lifts or below ground piston lifts for trucks, it may be necessary to manage the operations of positioning the load carrying devices with respect to the vehicle by the operator moving into the danger area. In these conditions, the use of remote control is allowed even if the lift is not suitable for working under the lifted vehicle while lift is moving but it shall be limited only to complete this positioning phase. Therefore at least one of the following conditions should be implemented.

- The remote control can work only for a limited lifting stroke from the ground level, enough to reach the correct positioning of the load bearing device (max 400 mm).
- The remote control is automatically switched off as soon as the load carrying device takes the load (load sensing) or reach the position (position sensing).

— If it is necessary to use the remote control to be able to operate under the lift (for example to put the vehicle on stands or to dismount part of the vehicle using the movement of the lift) the requirements of 4.22 should be fulfilled.

— In general: if none of the previously mentioned devices/features are present (additional consensus control device, limited stroke, ...) the operation through the remote control should automatically switch the lift to operation mode in accordance with the special condition required by 4.22.

Recognition modes for the connection between the wireless remote control and lift

The most likely cause of unintentional operation of a lift occurs when the wireless remote controls are swapped between the lifts in the same location by mistake or are brought to another location and operated by mistake.

Some examples of alternative control measures to avoid these unintentional operations.

— The remote control-lift combination should be easily identifiable.

  • To indicate which lift the remote control is connected to, an audible and/or visual warning 2 s before the lift starts moving as described in 4.4.1 could be used.

— Connections should end after the last operation or in certain situations.

  • Connections can be made valid for 5 min after the last operation.

  • There will be a visual indication (text message or control light) on the remote control for the duration of the valid connection. After 5 min from the last operation the remote control needs to be reconnected.

  • Connections can end when a certain situation is reached (e.g. down position).

  • Connections can end as soon as the remote control is out of a defined area.

— Reconnection can be made by pushing a button (like consensus control device) on the fixed control device or by an RFID-Tag in the remote control that has to be connected to the receiver on the fixed control.

— Wireless controls, when connected to a specific lift, can operate with a defined area around the lift vehicle (1,5 m around the floor projection of the vehicle) and should not function outside this area.

<u>To 4.7.4.2</u>

The purpose of Tab 3 is to define the characteristics of the Normative Vehicle that best represent, in compliance with the definition of the Normative Vehicle itself, the various categories of vehicles referred to in the current legislation.

The data reported in Table 3, while reflecting in principle the characteristics of the most common vehicles in circulation, are necessarily simplified with respect to the actual variability of these as they are aimed solely at constituting an adequate reference for the structural calculations of the lifts intended for lifting these vehicles, and therefore the values indicated refer to the most conservative conditions among those possible.

The classification, on which Table 3 is based, is made with reference to the maximum laden weight of the vehicle (excluding people), which is the fundamental reference for the rated load of the lift, the number of axles and the load distribution on the axles themselves.

For simplification, the multiple axles (double, triple axles), present in the categories relating to heavy vehicles are considered as a "virtual single axle" positioned on the centre-line of the multiple axles.

The minimum distances between axle load and platform ends (X1, X2) are defined with reference to the wheel size and axle type (single, double, triple axles).

In the load distributions of heavy vehicles (items "g ÷ o"), the generally existing limitations have been taken into consideration (steering axle max 10 t and non-steering axle max 13,5 t).

In items "g ÷ o", which includes trucks and buses weighing more than 7,5 t, the types indicated may not include different existing types, but compared to these, those included are the most conservative for the purpose of sizing the lift (e.g.: vehicles type "f" can also exist with double rear axle but here they are not considered because they would be less conservative than the single axle ones considered).

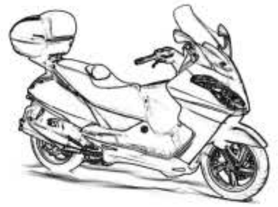
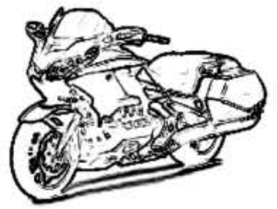
Due to the great variability of the characteristics of some vehicles (e.g. agricultural vehicles) not all vehicles are attributable to the concept of normative vehicle and therefore not all fall within the field of application of paragraph 4.7.4.2 and related Table 3.

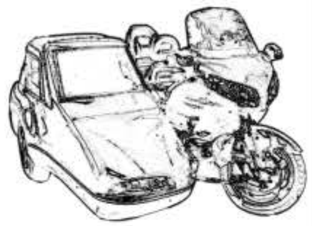
In general: vehicles not attributable to those indicated in Table 3, for sizing purposes, are to be considered special vehicles and as such fall within the scope of application of 4.7.4.4.

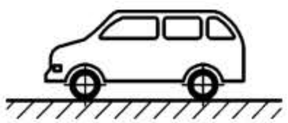
In Table C.1, taking up the scheme of Table 3, the main characteristics of the categories attributable to the concept of normative vehicle are reported, with examples for clarification.

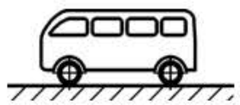
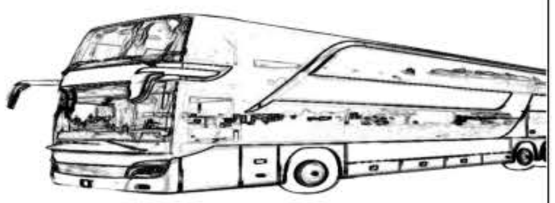
In Table C.2 are reported examples of categories not attributable to the normative vehicle.

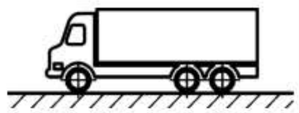
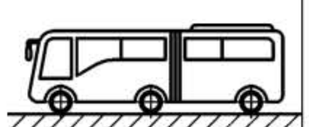
Table C.1 — Vehicle categories and examples

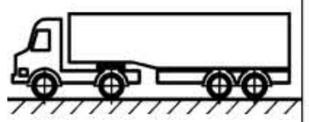
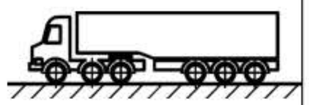
		VEHICLES CATEGORIES AND EXAMPLES					
a	**P ≤ 0,6**	**- Two wheeled motorcycles** **L1** Engine < 50cc, speed < 45Km/h **L3** Engine > 50cc Speed > 45km/h		**L1** 	**L3** 	**L3** 	**L3** 

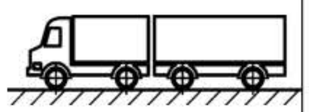
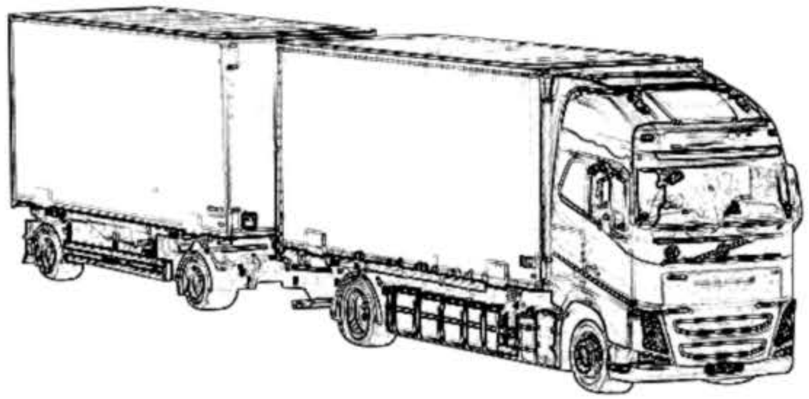
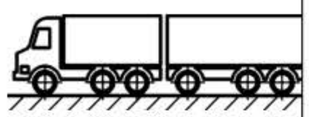
b	**P ≤ 1**	**- Three wheeled motorcycles** **L2** Engine < 50cc, Speed < 45Km/h, Weight < 270kg **- Two wheeled motorcycles with side-car** **L4** **- Powered tricycles** **L5** Engine > 50cc, Weight < 1000kg		**L2** 	**L4** 	**L5** 	
c	**P ≤ 1**	**- Light quadricycles** **L6** Speed < 45Km/h, Weight < 425kg **- Heavy quadricycles** **L7** Weight < 450/600 Kg		**L6** 	**L6** 	**L7** 	**L7** 

d	**P ≤ 2,5**	**- Passenger cars** **M1** Seats < 8+1 **M2** Seats > 8+1 seats Weight < 5 t		**M1** 		**M1** 	**M2** 
e	**2,5 < P ≤ 3 ,5**	**- Passenger cars, -** **M1** Seats < 8+1 **M2** Seats > 8+1 seats Weight < 5 t **- Light trucks** **N1** Weight < 3,5 t		**M1** 	**M2** 	**M1** 	**N1** 

f	**3,5 < P ≤ 7 ,5**	**- Busses** **M3** Seats > 8+1 Weight > 5 t **- Trucks** **N_2** Weight 3,5 ÷ 12 t		**M3** 		**N_2** 
g	**7,5 < P ≤ 2 0**	**- Busses** **M3** Seats > 8+1 Weight > 5 t **- Lorries** **N_2** Weight 3,5 ÷ 12 t **N3** Weight > 12 t		**M3** 	**N_2** 	**N3** 

h	**20 < P ≤ 30**	**- Lorries** **N3** Weight > 12 t		**N3** 
i	**30 < P ≤ 40**	**- Dumper trucks /Tipping vehicles** **N3** Weight > 12 t		**N3** 
j	**P ≤ 25**	**- Articulated busses** **M3** Seats > 8+1 Weight > 5 t		**M3** 

k	**P ≤ 40**	**- Articulated lorries** **N3** Weight > 12 t **O3** Weight 3, 5 ÷ 10 t **O4** Weight > 10 t		**N3+O3/04** 
l	**40 < P ≤ 52**	**- Articulated lorries** **N3** Weight > 12 t **O3** Weight 3,5 ÷ 10 t **O4** Weight > 10 t		**N3+O3/04** 

m	**P ≤ 40**	**- Lorries with trailers** **N3** Weight > 12 t **O3** Weight 3,5 ÷ 10 t **O4** Weight > 10 t		**N3+O3/04** 
n	**40 < P ≤ 52**	**- Lorries with trailers** **N3** Weight > 12 t **O3** Weight 3,5 ÷ 10 t **O4** Weight > 10 t		**N3+O3/04** 

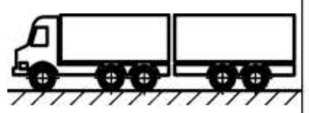
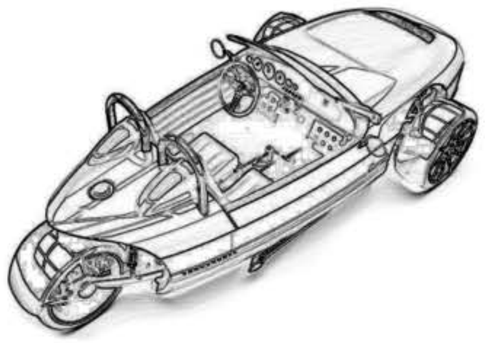
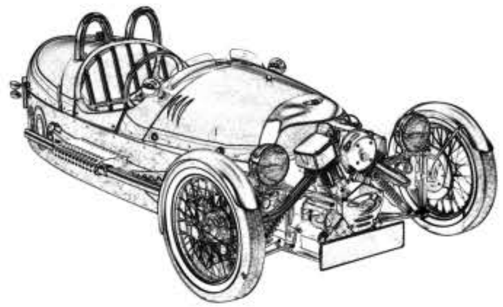
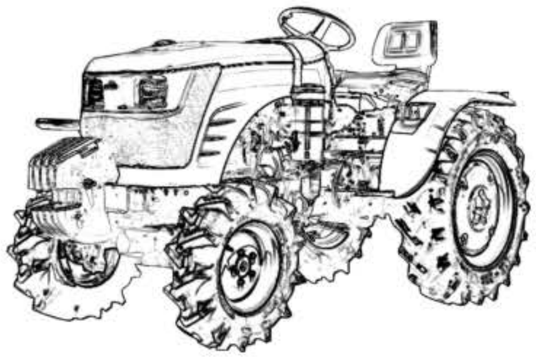
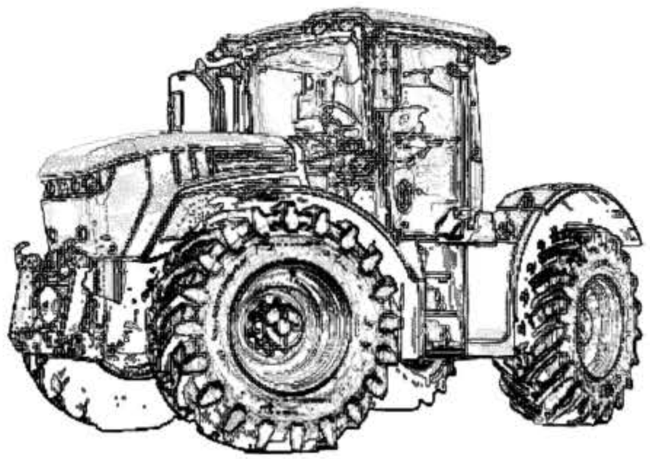
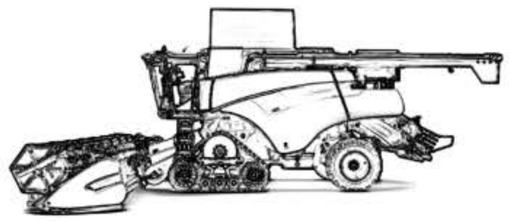
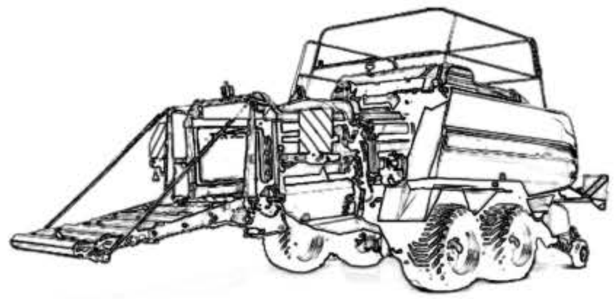
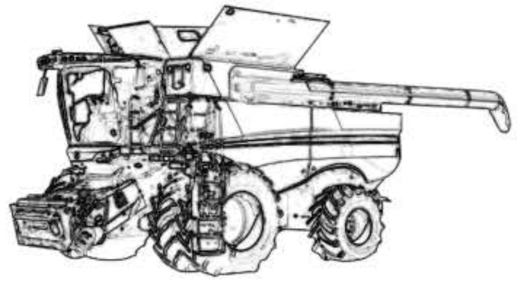
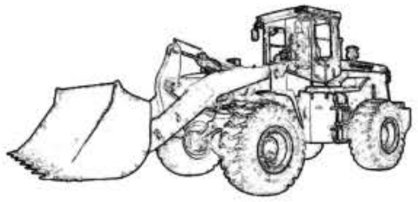
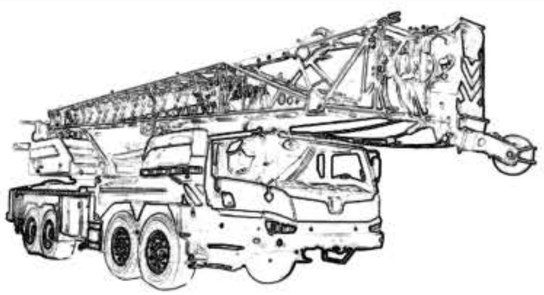
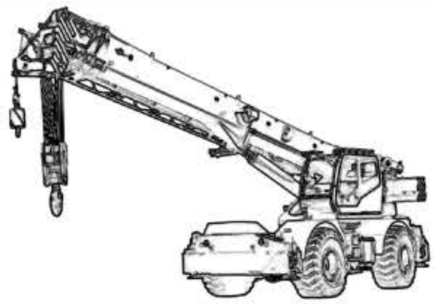
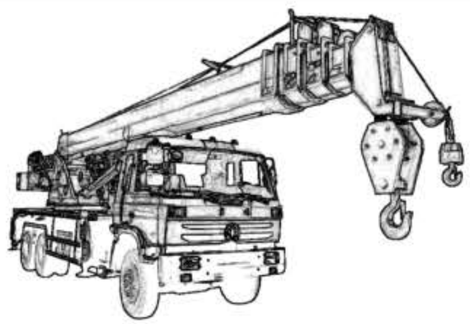
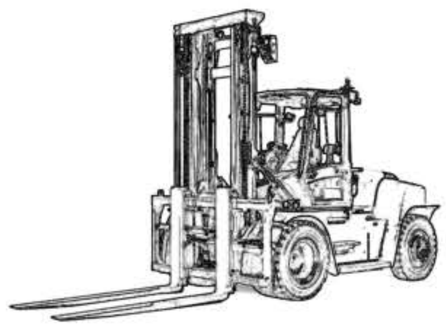
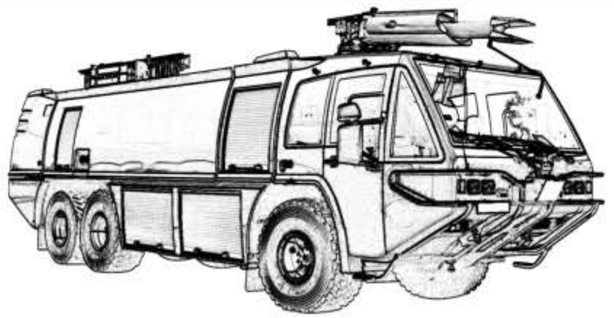
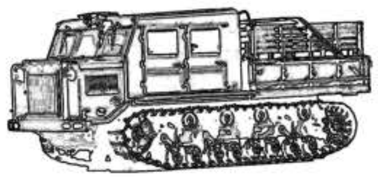
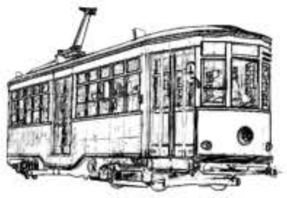
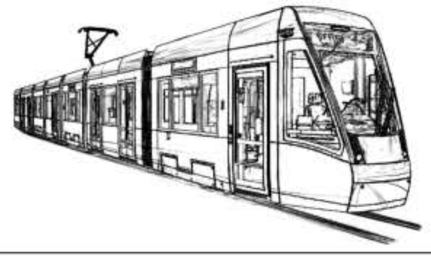
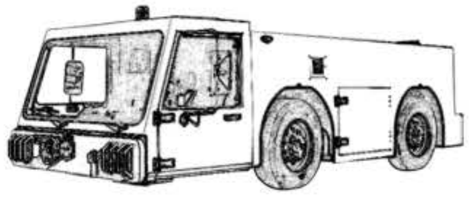
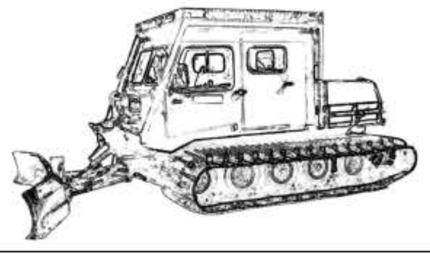
o	**P ≤ 45**	**- Lorries with trailers** **N3** Weight > 12 t **O3** Weight 3,5 ÷ 10 t **O4** Weight > 10 t		**N3+O3/04** 

Table C.2 — Examples of special vehicles

	SPECIAL VEHICLES		
Three wheeled cars			
Agricultural tractors			

Agricultural machines			
Earth moving machines			
Mobile cranes			

Forklifts			
Firefighter vehicles			
Army vehicles			

Trams, Rail vehicles			
Others			

To 4.7.4.3

The figures below show some example of the different load conditions for a two post lift with capacity < 3,5 t.

a) Load rectangle 100 cm x 140 cm (see Figure C.17)

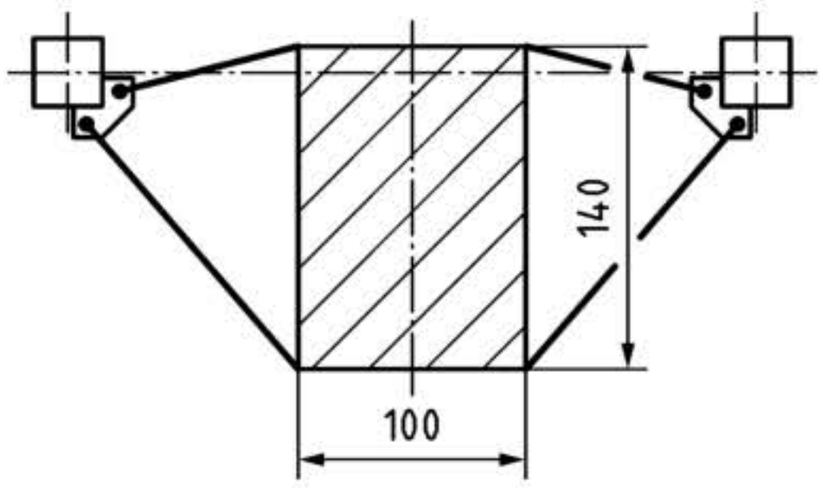


Figure C.17 — Load rectangle 100 cm x 140 cm

— Long arm fully extended and rotated to intercept distance 100cm in the wheel-track direction;

— Short arm extended as far as necessary to intercept the distance 140 cm;

— The geometry of the lift allows reaching the load rectangle 100 cm x 140 cm: the calculation shall be done with reference to load rectangle 100 cm x 140 cm.

b) Load rectangle 160 cm x 140 cm (see Figure C. 18 and C.19)

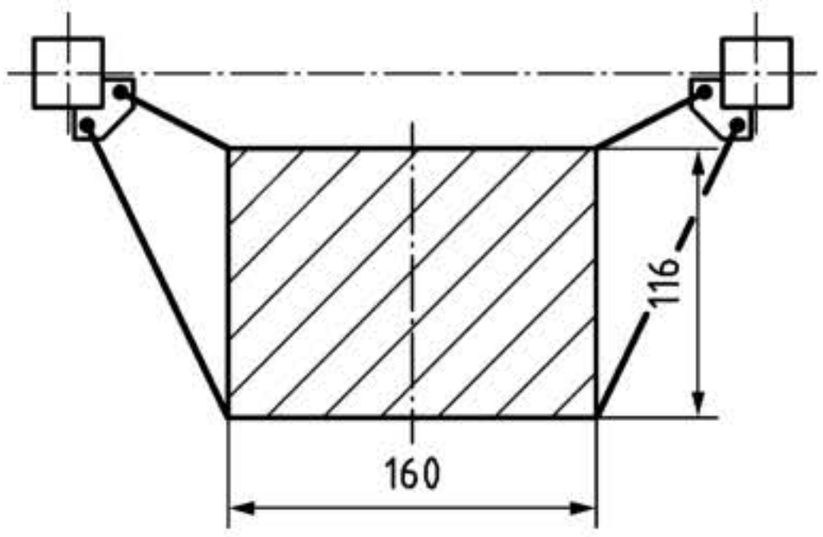


Figure C.18 — Load rectangle 160 cm x 140 cm – not usable

— Long arm fully extended and rotated to intercept distance 160 cm in the wheel-base direction;

— Short arm at minimum length and rotated on the same side of the long arms, at minimum length up to intercept the distance 160cm in the wheel-track direction;

— The geometry of the lift does not allow reaching the load rectangle: 160 cm x 140cm;

— The result is a load rectangle with a dimension of 116cm in wheelbase direction, lower than the theoretical one of 140 cm, and therefore, according with 4.7.4.3, not usable for calculation.

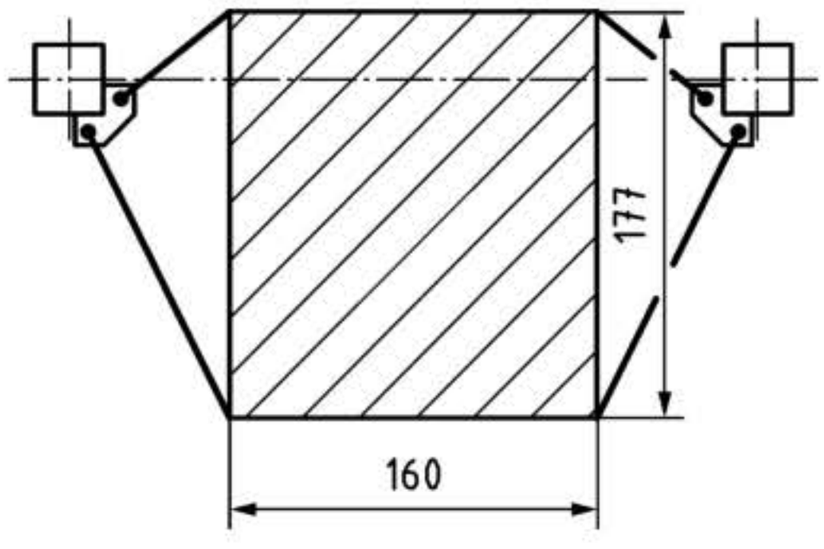


Figure C.19 — Load rectangle 160 cm x 140 cm – usable

— Same as Figure C.18 but short arm rotated on the opposite side of the long arms, at minimum length;

— The geometry of the lift does not allow reaching the load rectangle:160 cm x 140 cm;

— The result is a load rectangle with a dimension of 177 cm in wheelbase direction;

— The calculation shall be done with reference to load rectangle 160 cm x 177 cm.

The above examples support the following basic concept.

If the normative load rectangle is not reachable from the lift geometry, the sizing of the lift shall be done on the basis of the load rectangle that is closest to the theoretical one, respecting the condition that none of the dimensions shall be less than the corresponding one of the normative load rectangle.

To 4.8.1

I. General

In general, the term "uncontrolled motion" means any non-commanded movement and therefore involuntary movement.

However, two cases should be distinguished:

a) Involuntary movement generated starting from stationary conditions of the lift (e.g. hydraulic lift in use but stationary at height: a hydraulic leak can generate the involuntary downwards movement).

b) Inertial type involuntary movement, due to failure to stop in the event of command cease (e.g. electromechanical screw lift: when the down button is released, there is no instantaneous stop so that the movement that remains is involuntary because it is not commanded).

II. Hydraulic or pneumatic driven lifts

In this type of lifts the involuntary movement can be of both mentioned types and could be due to leakage in the cylinder or in the circuit.

Refer therefore to 4.14.2 "Protection against leakage".

III. Screw driven lifts

In this case also, the involuntary movement can be of both mentioned types but the causes are different.

III a) Involuntary movement of type a)

The lift does not maintain the position at height but from the standstill condition it starts to move and gradually goes down. This is a static irreversibility defect.

This involuntary movement can be avoided through the use of:

a1) Self-braking screw;

or

a2) Self-braking drives (drives: lifting screws directly coupled to transmission components such as worm gear box);

or, when a) and b) are not completely fulfilled;

a3) An additional automatic brake, that compensates for the incomplete irreversibility of the system, taking care of the remaining torque.

a1) Self-braking screw (see Figure C.20):

— The necessary and sufficient condition for a lifting screw to be considered irreversible is that the direct motion efficiency is less than 0,5.

— The degree of irreversibility can therefore be determined by calculating the efficiency of the direct movement taking into account the geometrical aspects of the coupling (thread helix, inclination of the thread side, ...) and friction coefficient

$$\eta_{screw} = \frac{\mathrm{tg}\,\alpha}{\mathrm{tg}\left(\alpha + \varphi'\right)} < 0,5$$

where

η_{screw} efficiency of the direct movement;

α inclination of the helix with respect to the average diameter of the thread.

$$\alpha = \mathrm{arctg}\,\frac{\mathrm{p}}{\mathrm{d_m}\pi}$$

where

P = thread pitch;

$\mathrm{d_m}$ = thread average diameter;

ϕ' is the assumed friction angle (function of the coefficient of friction as well as of the characteristic angles of the thread).

$$\phi' = \mathrm{arctg}\, f\,\frac{\cos\alpha}{\cos\gamma}$$

where

f friction coefficient

the most serious conditions for self-braking performances are when the friction coefficient is low; therefore, in the calculation, a coefficient higher than the values indicated below shall not be used.

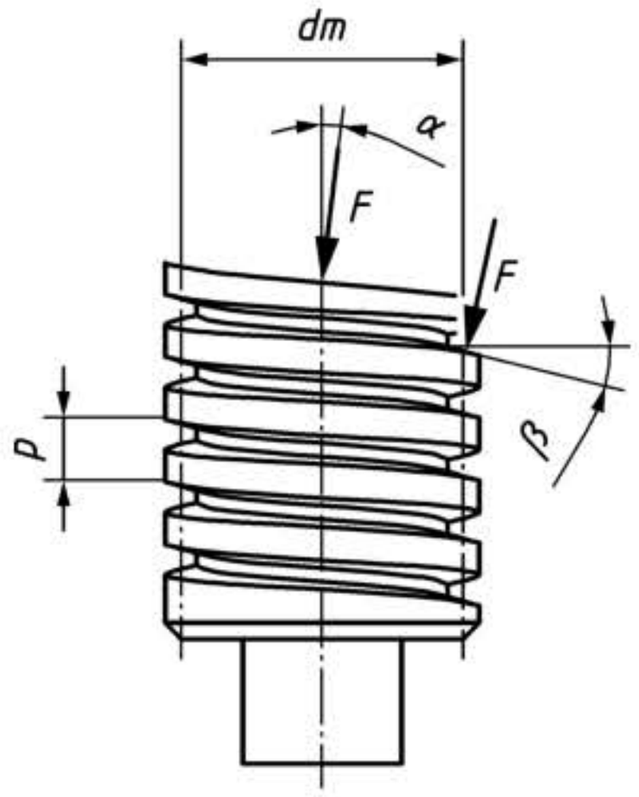
f = 0,06 lubricated bronze/steel contact;

f = 0,04 lubricated or not lubricated polyamide/steel contact.

It's acceptable to use higher friction coefficients if the test is certified by third party (e.g. qualified laboratory, material/part manufacturer) proves that they are reliable. This allows the manufacturer to use materials with adequate values of the coefficient of friction such as to guarantee irreversibility without having to add brakes or similar devices.

$$\cos\gamma = \frac{1}{\sqrt{1 + tg^2\alpha + tg^2\theta}}$$

In the case where the geometric characteristics of the threaded coupling do not satisfy the condition (*) it is possible to proceed to the verification of the irreversibility of the whole system (see point a2-a3) or the global irreversibility should be proved through **experimental test**. The test should be significant for the purposes.



Key

dm	thread pitch diameter
α	thread helix angle
F	load transmitted to the screw by the nut
Θ	thread flank angle
P	thread pitch

Figure C.20 — Self braking screw

Test Method

a) Brand new lift (certification test)

The test should be carried out on a lift in perfect lubrication conditions on all the elements that contribute to influencing the involuntary starting of the downward movement.

The lift should be loaded with the rated load and the load distribution in accordance with 4.7.4.

When the lift is raised and stationary, measure with a torque wrench (or equivalent) the value of the torque necessary to release the downward movement: if this value is higher than 40 Nm the test is successfully passed.

If it is impossible to apply a torque wrench, the test can be done by checking the amount of inertia movement following the release of the down command. If this movement does not exceed 1 rotation of the screw (or nut) the test can be considered satisfied.

b) Lift already in operation (periodical check)

Same procedure as in case a) but with acceptance limit decreased from 40 Nm to 10 Nm.

Again, if it is impossible to apply a torque wrench, the test can be done by checking the amount of inertia movement following the release of the down command. If this movement does not exceed 3 rotations of the screw (or nut) the test can be considered satisfied.

a2) Self braking drives

The necessary and sufficient condition for a lifting screw drive to be considered irreversible is that the direct motion efficiency is less than 0,5.

$\eta_{tot} = \eta_{screw} \times \eta_{oe} < 0,5$

Efficiency of the screw, η_{screw}, calculation is given in a).

Efficiency of other elements η_{oe} of the drive depend on the elements themselves and should therefore be determined by experiment or calculation.

a3) Automatic brakes

— The automatic brake should be able to guarantee a braking torque able to make up for the non-complete static irreversibility of the system.

— The brake system should work automatically when power supply to driving motor is cut (for any reason).

— This automatic brake system should ensure that the load is stopped and held in any foreseeable condition.

— Unintended lifting of the brake should be prevented.

— For general requirements for safety brakes see also 4.18.5.

III b) Involuntary movement of type b)

— In screw driven lift, when the down command is released, unless the brake motors are rigidly connected (e.g. through gearboxes) to the lifting screw, it may not be possible to stop the movement instantaneously. Any involuntary movement should be limited in such a way as not to affect the safety of the machine. The limitation of the extent of the involuntary movement can be made through adequate automatic braking device.

— In the event that this movement cannot cause misalignment between the lifting units (i.e. in the case of lifts without independent elements, e.g. two-column lift with transmission bar) the involuntary movement should take place with a speed lower 10 mm/min (as indicated in the 4.8.1) and should be limited to a maximum of 100 mm.

— In the case of multiple lifting unit lifts, the involuntary movement can cause misalignment therefore it should be limited to a maximum of 50 mm (or to the linear value corresponding to 1 ° of inclination of the vehicle in accordance with the provisions of 4.15) and in any case during the movement the synchronization control should stay active to maintain control of the position and allow the resumption of operations without introducing errors.

To 4.8.2

Examples of self-locking means include non-return valves which lock the hydraulic pressure medium in the cylinder, latches and self-braking systems.

To 4.8.5.2

The requirement is fulfilled if, for example, a system consisting latches is provided.

To 4.8.5.4

The requirement is fulfilled if, for example, a pressure reduction valve is fitted.

To 4.12

This requirement does not refer to the possibility that there might be an obstacle, placed in the area below the lift or raised vehicle, which may stop any downwards motion or may even dislodge the vehicle.

The operator should keep the work area below the lift and any raised vehicle under proper control and ensure there are no obstructions likely to create a hazardous situation when lowering the lift and vehicle.

The requirement in 4.12 recognizes that, unknown to the operator, there may be an unseen impediment or mechanical failure obstructing the actions of one or more lifting elements and which prevent complete downward motion of the lift, e.g. the involuntary engagement of a latch in scissors lifts or an unprovoked locking of a safety latch on the ropes of a 4-post lift.

Vehicle lifts in which the lowering motion of a load carrying device is achieved by gravitational force may just stop lowering or the lifted vehicle could be dislodged. If the lifting device is powered downwards damage could be caused to the lift's elements as well as the vehicle.

For vehicle lifts where the load carrying devices are suspended on wire ropes or chains, a safety switch should stop the lowering movement in the event of slack rope or chain.

Screw driven vehicle lifts and those with hydraulic bearing devices where the load carrying device is not fixed to the load bearing nut or hydraulic cylinder should also stop lowering when meeting an obstruction.

In this case the lowering movement should be stopped by means of a switch (or equivalent device) which detects separation of the load carrying device and the nut or cylinder.

To 4.13

This safety requirement is fulfilled if, for example:

— a mechanical, automatic operating catching device; or

— unloaded ancillary lifting elements

are provided.

Any ancillary lifting elements, whatever its type or style, should be unloaded during normal operation.

Sample of solutions:

— Screw driven lifts: safety nut, catching device;

— Hydraulically driven lifts with one cylinder and one rope/chain per suspension point: automatic catching device (activated by an overspeed governor or chain/rope failure detector);

— Hydraulically driven lifts with one cylinder and two or more rope/chain per suspension point: rope/chain failure detector.

To 4.14.1

The requirements fulfilled if, for example, a flow rate control valve (pipe rupture valve, restrictor) set to limit the lowering speed within a maximum 1,5 of the normal lowering speed, is installed on the hydraulic cylinder or may be separate from the cylinder as long as the connection between the valve and the cylinder is made with a rigid pipe suitably dimensioned not to restrict flow to the cylinder or distort under the weight of the valve.

To 4.14.2

This requirement should be fulfilled by means of a catching device consisting of latches or other systems that prevent uncontrolled moving.

Sample of solutions:

— Lift with two lifting units: latches or total hydraulic redundancy per drive system;

— Lift with two mechanically connected lifting units, with one cylinder per lifting unit: each cylinder designed to carry the total load, mechanical connection designed for half the load, pilot operated non-return valve on each cylinder or latches.

The assumption "It is assumed that no more than one leakage in the circuit is considered at the same time" assumes the simultaneous occurrence of the leakage extremely unlikely.

It follows that to avoid the simultaneous presence of two leakages it should be possible to find the first one so that it is resolved before the second arises, which would give rise to the condition of two simultaneous but not improbable defects, and therefore be avoided.

The detection of the first defect can be entrusted to the presence of automatic detection devices (directly or even indirectly, checking the consequences of the defect) or even delegated to the attention of the operator but only if the occurrence of the defect is not instantaneous and on condition that adequate instructions are provided on how to detect the problem.

Usually the total hydraulic redundancy is guaranteed in hydraulic driving system of lifts with two lifting units where each lifting unit is supported on at least two independent lifting elements, such that a single leakage cannot compromise the stability of the load.

In case of a leakage, lowering of the load should be possible, but appropriate measures shall be taken to allow it without compromising the stability of the load.

Appropriate guidance shall be provided in the information for use to allow the user to recognize anomalies in the working conditions (e.g. reduced lifting capacity, variation in working speed, noise, ...) that highlight the presence of problems with operation of the lift.

To 4.15

The requirement can be fulfilled by use of control systems or by mechanical connecting systems (e.g. chains or cardan shafts).

The requirement also means that chains used for the transmission of power between lift screws should be provided with a slack chain switch or similar device which prevents dangerous asynchronization of the load carrying devices in the event of a broken or disengaged chain.

To 4.16.1

In the case of mobile vehicle lifts the requirement is fulfilled if there are:

a) lockable parking brakes on at least two wheels; or

b) spring loaded wheels in at least two positions so that the loaded lift cannot be moved; or

c) supports lifting at least two wheels from the ground; or

d) at least one automatically retractable wheel when the load is applied.

To 4.18.4

The requirement is fulfilled:

— if re-raising from the initial position is prevented in situations where unloaded ancillary lifting elements are fitted according to 4.13;

— in all other cases if all motions are stopped.

To 4.18.5

This requirement can be fulfilled by the use of compression springs with both ends fixed or by selection of springs such that the wire diameter is greater than the distance between the coils, hence preventing the two pieces from winding into each other in the event of a breakage.

To 4.20

Requirement c) is fulfilled if:

— securing mechanisms such as snap-in latches or locking springs are fitted; or

— the distance that winding handles or levers up to a length of 250 mm can be pushed in their shafts is at least one-fifth of their own length.

To 6.3.1 w 1)

The operator shall take into account that the use of a single pair of independent lifting units on a multiple axle vehicle can cause overload as soon as the majority of or all of the axles detach from the ground as the supporting pair of independent lifting units is progressively loaded by the weight of the axle on which no independent lifting units are engaged.

To 6.4

The requirement “permanently fixed” is fulfilled, for example, if tools are required to fix and remove the nameplate. Stamped letters and numbers also fulfil this requirement.

Annex D
(informative)

Example of information about wind

Maximum allowed wind speeds for different types of vehicles see Table D.1

Table D.1 — Information about wind

Vehicle type	**Empty weight** t	**Max. allowed wind speed** m/s
Cars, caravans, long swap lorries	from 1 to 10	14
Bus, articulated lorries	from 10 to 15	20
Lorries and heavy vehicles	greater than 15	24

Annex E
(normative)

Test procedure for unintended blocking of the load carrying device
(4.12)

The test shall be carried out with the lift loaded with the rated load and placed in the most severe condition with respect to the test in progress. If the results of the tests do not depend on the load condition it is acceptable to perform the test with an unloaded lift.

The load bearing device shall be brought to a height corresponding to a lifting stroke greater than 500 mm.

External safety devices shall be provided to ensure that in the event of a negative result of the test (failure to stop the movement within the prescribed limits) there are no problems of load instability or risks to those who are doing the test.

An obstacle (of adequate resistance) shall be applied in the most suitable position to simulate the problem (making sure that there is no risk of expelling the obstacle itself) or operating so as to reproduce the problem (for example, in the case of tests on scissor lifts, by removing the supply of air that keeps the latches disengaged).

It shall be verified that the down movement stops within the required limits and that, after the stop has been achieved, only motion in the opposite direction is possible.

Annex F
(normative)

Additional requirements for wireless controls and control systems

F.1General

Wireless controls shall be designed according to 9.2.7 of EN 60204-32:2008 with the following additions.

F.2Movement command

The wireless control station shall not send any movement command whilst the means to prevent unauthorised use is activated.

F.3Control limitation

F.3.1 Activation of the wireless control station and the data communication shall be indicated on the wireless control station and shall not initiate any movement of the vehicle lift.

F.3.2 A movement command shall only be active when the receiver receives a correct message. For detailed requirements, see F.5.

F.3.3 A movement command received by a message shall only be accepted if at least one correct message without any movement commands is received first.

F.3.4 To avoid inadvertent movements after any situation having caused the lift to stop (e.g. power supply fault, battery replacement or lost signal condition), the system shall only output operating commands resulting in any lift movement after the operator has returned the controls to “off” position for a suitable period of time, i.e. it has received at least one frame without any operating commands.

F.4Stop

The emergency stop function is a safety related part of the lifts control system, as defined in 3.1.1 of EN ISO 13849-1:2015 and shall be designed to performance level d or higher according to EN ISO 13849-1:2015.

F.5Serial data communication

F.5.1 When data communication is used in the implementation of a safety function then the residual error rate of the communication process shall be estimated taking into account transmission errors, repetitions, deletion, insertion, re-sequencing, corruption, delay and masquerade. This residual error rate shall be taken into account when estimating the performance level of the safety function due to random failures (see Table F.1).

Table F.1 — Failures and safety measures

Communication errors	Safety measures							
	Sequence number	**Time stamp**	**Time expectation**	**Connection authentication**	**Feedback message**	**Data integrity assurance**	**Redundancy with cross checking**	**Different data integrity assurance systems**
Corruption					X	X	Only for serial bus [d]	
Unintended repetition	X	X					X	
Incorrect sequence	X	X					X	
Loss	X				X		X	
Unacceptable delay		X	X [c]					
Insertion	X			X [a,b]	X [a]		X	
Masquerade				X [a]	X [a]			X
Addressing				X				

NOTE Table adapted from IEC 62280-2:2017.

[a] Depends on application.

[b] Only for sender identification. Detects only insertion of an invalid source.

[c] Required in all cases.

[d] This measure is only comparable with a high quality data assurance mechanism if a calculation can show that the residual error rate ∧ reaches the values required in IEC 62280:2017, 5.4.9 when two messages are sent through independent transceivers.

F.5.2 There shall be a continuous data communication so that communication faults (e.g. deletion) are detected by the system.

F.5.3 The residual error rate is calculated from the residual error probability of the superimposed (safety) data integrity assurance mechanism and the transmission rate of safety messages. In addition, one shall take into account the maximum number of information sinks (m) that are permitted in a single safety function (see Table F.2).

Table F.2 — Relationship of residual error rate to performance level pl

Application for safety functions up to pl	Probability of a dangerous failure per hour for the functional safety communication system	Maximum permissible residual error rate for the functional safety communication system
e	$< 10^{-9}$ / h	$\Lambda < 10^{-9}$ / h
d	$< 10^{-8}$ / h	$\Lambda < 10^{-8}$ / h
b/c	$< 10^{-7}$ / h	$\Lambda < 10^{-7}$ / h
NOTE Values in this table are based on the assumption that the functional safety communication system contributes no more than 1 % of the total failures of the safety function.		

Formula (F.1) shown below shall be used to calculate the residual error rate resulting from RSL (Pe) unless the underlying model does not apply or if another method may be more relevant. Items of the formula are specified in Table F.3.

$$\Lambda SL\left(Pe\right) = RSL\left(Pe\right) \times v \times m \qquad \text{(F.1)}$$

NOTE This formula assumes cyclic transmission of safety messages.

Table F.3 — Formula items

Formula items	Definition
$\Lambda_{SL}\left(Pe\right)$	Residual error rate per hour of the safety communication layer with respect to the bit error probability.
Pe	Bit error probability. Unless a better error probability can be proven, a value of 10^{-2} shall be used.
$R_{SL}\left(Pe\right)$	Residual error probability of a safety message.
v	Maximum number of safety messages per hour.
m	Maximum number of information sinks that is permitted in a single safety function.

F.5.4 The control system shall initiate a stop of all lift movements when no valid frame has been correctly received within 1,0 s. The foreseen usage of the lift shall be tested to ensure that additional hazards do not result from this extension of the time value.

F.6Use of more than one operator control station

F.6.1 Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.

F.6.2 Means shall be provided to enable several transmitter/receiver pairs to operate in the transmission range without unwanted interference with each other.

F.6.3 The means provided in F.6.2 shall be protected from accidental or unintentional change.

F.7Battery-powered operator control stations

A variation in the battery voltage shall not cause a hazardous situation. If one or more potentially hazardous motions are controlled using a battery-powered wireless operator control station, a clear warning shall be given to the operator when a variation in battery voltage exceeds specified limits. Under those circumstances, the wireless operator control station shall remain functional long enough for the operator to put the vehicle lift into a non-hazardous situation.

NOTE A time period of 10 min is normally acceptable.

F.8Wireless control components

The wireless control components (transmitter and receiver) shall have sufficient mechanical strength against environmental influences and expected loads, such as vibration and bump.

NOTE See e.g. IEC 60068-2-6:2008, IEC 60068-2-27:2009, IEC 60068-2-75:2007, IEC 60068-2-31:2008.

Annex G
(normative)

Deflection test of a chassis supporting lift with carrying arms

G.1 Criteria for carrying out a deflection test of a chassis supporting lift with carrying arms

The test shall be performed under the following conditions:

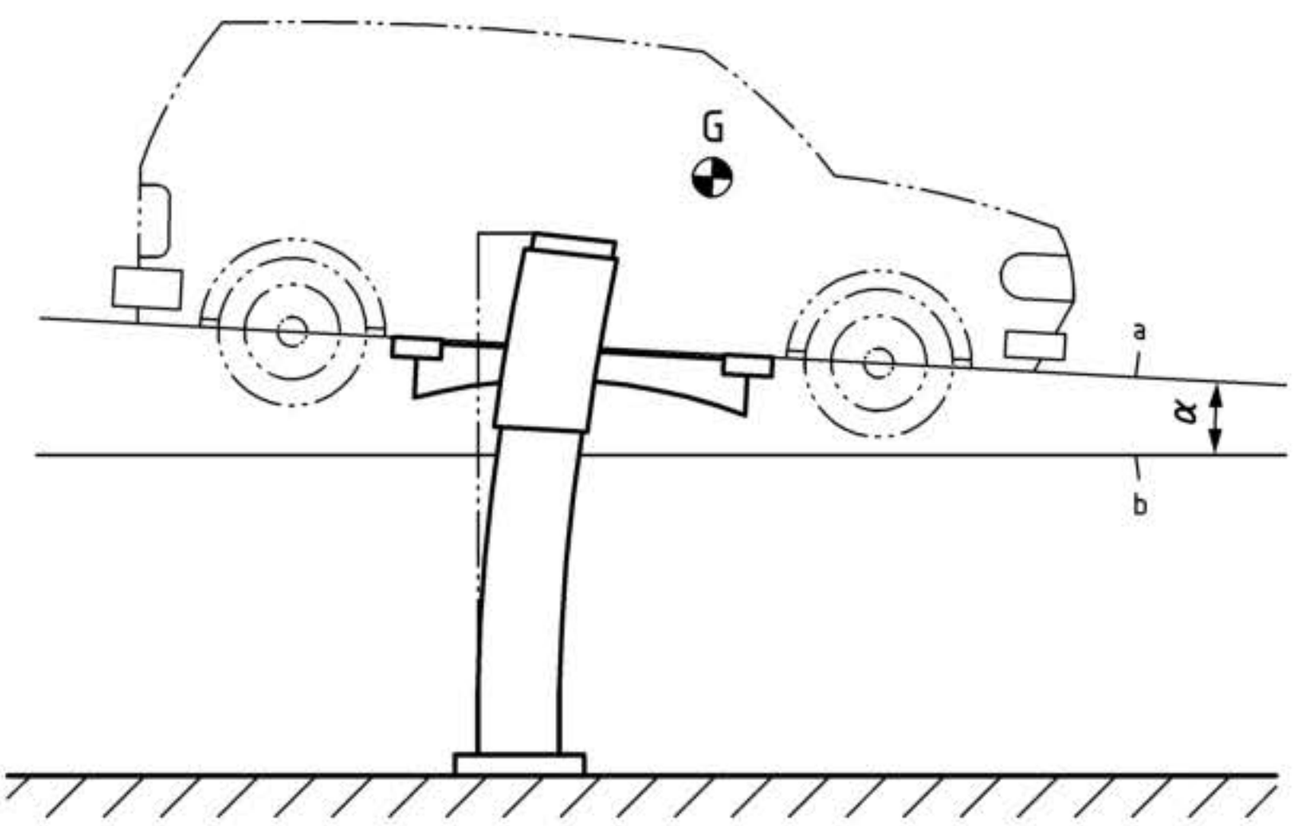
— The lift shall be correctly installed on a horizontal floor and the pick-up points shall be adjusted to the same height relatively to the floor;

— rated load as test load, conditions according to 4.7.4.3 a) and b) or 4.7.4.4;

— raise and lower the test load totally three times;

— lift the load to the maximum height and measure the angle between the level of the load bearing points and the horizontal line.

The angle of inclination (α) created by elastic deformation shall not exceed 3 degrees (see Figures H.1 and H.2).



Key

a vehicle underbody reference line. Corresponds to the track of the plane containing the pickup points on the underbody of the vehicle (on the assumption that these are, with the vehicle completely lowered, at the same height from the ground level)

b horizontal reference line

α vehicle tilt angle

G vehicle centre of gravity (load application point corresponding to the lift rated load)

Figure G.1 — Deflection test

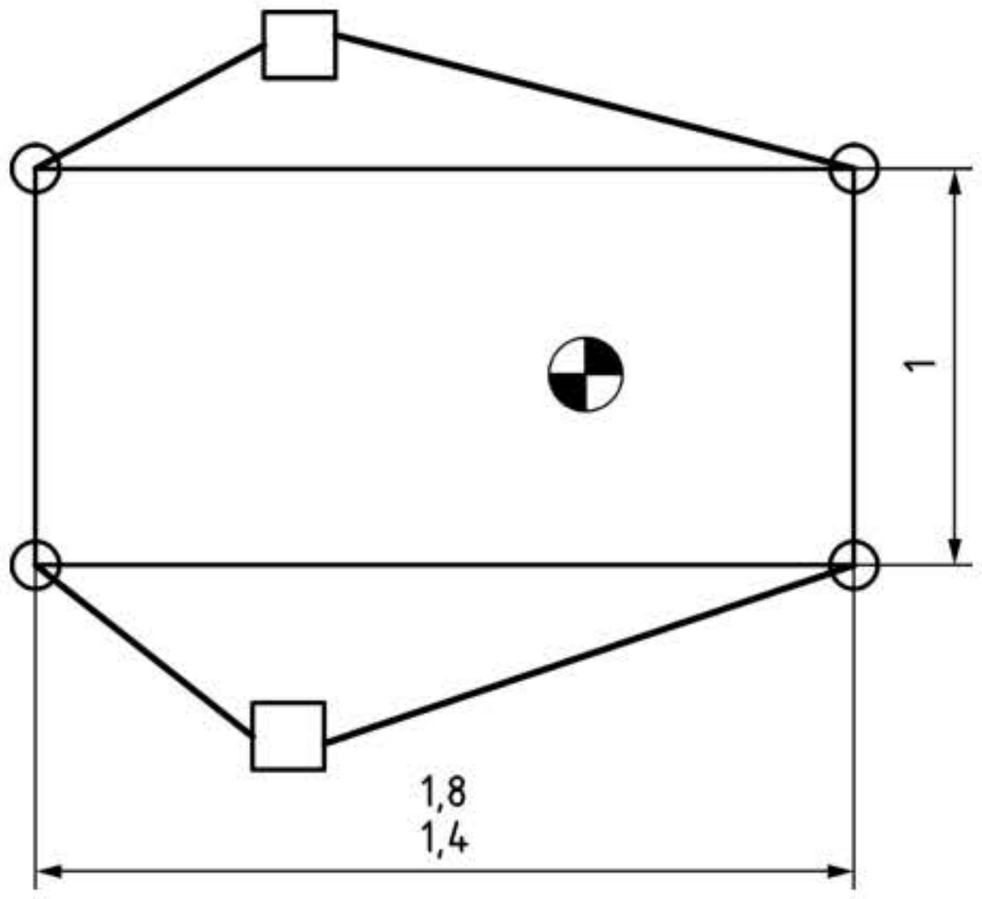
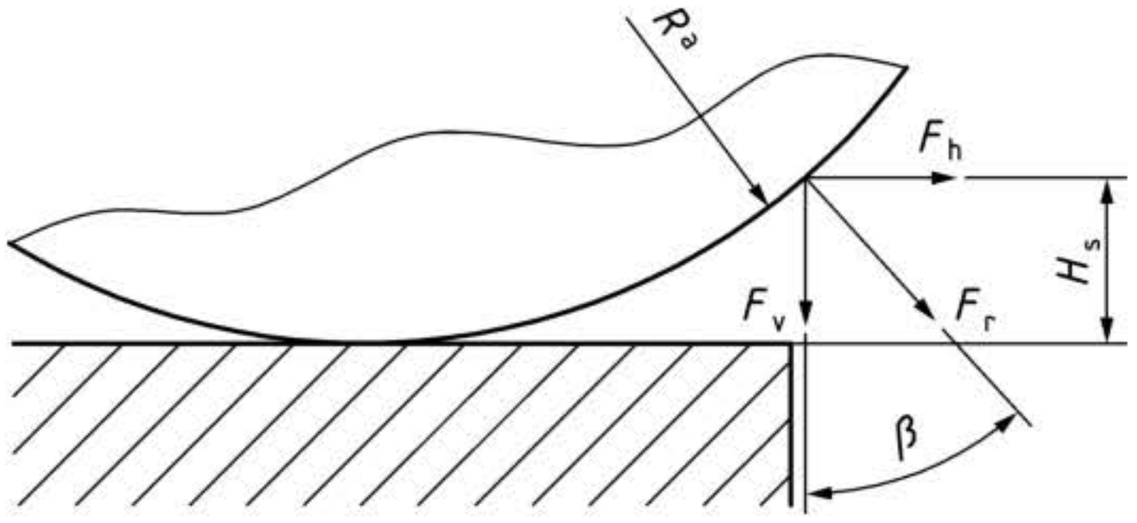


Figure G.2 —Test set-up

Annex H
(normative)

Test method for platform end stop



Key

a max. wheel radius

Figure H.1 — Resulting forces

Table H.1 — Forces

		Normative vehicle		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
Vehicle weight (mx) = rated load	M	kg		600	1000	1000	2500	3500	7500	20000	30000	40000	25000	40000	52000	40000	52000	45000
Horizontal force (20 % of rated load)	Fh	N	[M*0,2*9,81]	NA	1962	196	4905	6867	14715	39240	58860	78480	49050	78480	102024	78480	102024	
Height of end stop(s)	Hs	mm		NA325	100	100	100	100	100	100	105	105	105	105	105	105	105	105
Wheel radius	R	mm		NA	225	275	385	385	385	450	525	525	525	525	525	525	525	525
Ref. contact angle	ß	°	[arccosine((R-Hs)/R)]	NA	56	50	42	42	42	39	37	37	37	37	37	37	37	37
Vertical force on one device	Fv	N	[Fh/tan(ß)]	NA	1311	1619	5401	7561	16202	48557	78480	104640	65400	104640	136032	104640	136032	117720
Radical force on one device	Fr	N	$[\sqrt{\left(Fh^2 + Fv^2\right)}]$	NA	2360	2543	7296	10214	21887	62430	98100	130800	81750	130800	170040	130800	170040	147150

Values in the table are calculated for the maximum rated load in each normative vehicle category.

For lifts designed for a lower than maximum rated load, the forces may be calculated according to this rated load. (e.g. a 16000 kg rated load results in an Fh of 31392 N).

The test shall be carried out by force introduction at the upper edge of the end stop (most unfavourable point of contact between the tyre and the end stop, see Figure H.1 and Table H.1), considering a distribution on the width of the tyre as given below:

— Normative vehicles a through g: 150 mm.

— Normative vehicle h: 200 mm.

— Normative vehicles h through o: 250 mm.

a) With a vehicle, testing with 2 end stops.

A simple method for testing is by means of a (normative) vehicle with a weight equal to the rated load of the lift, with wheel dimensions as given in Table 3, which is positioned with the wheels with the smallest axle load contacting the end stops.

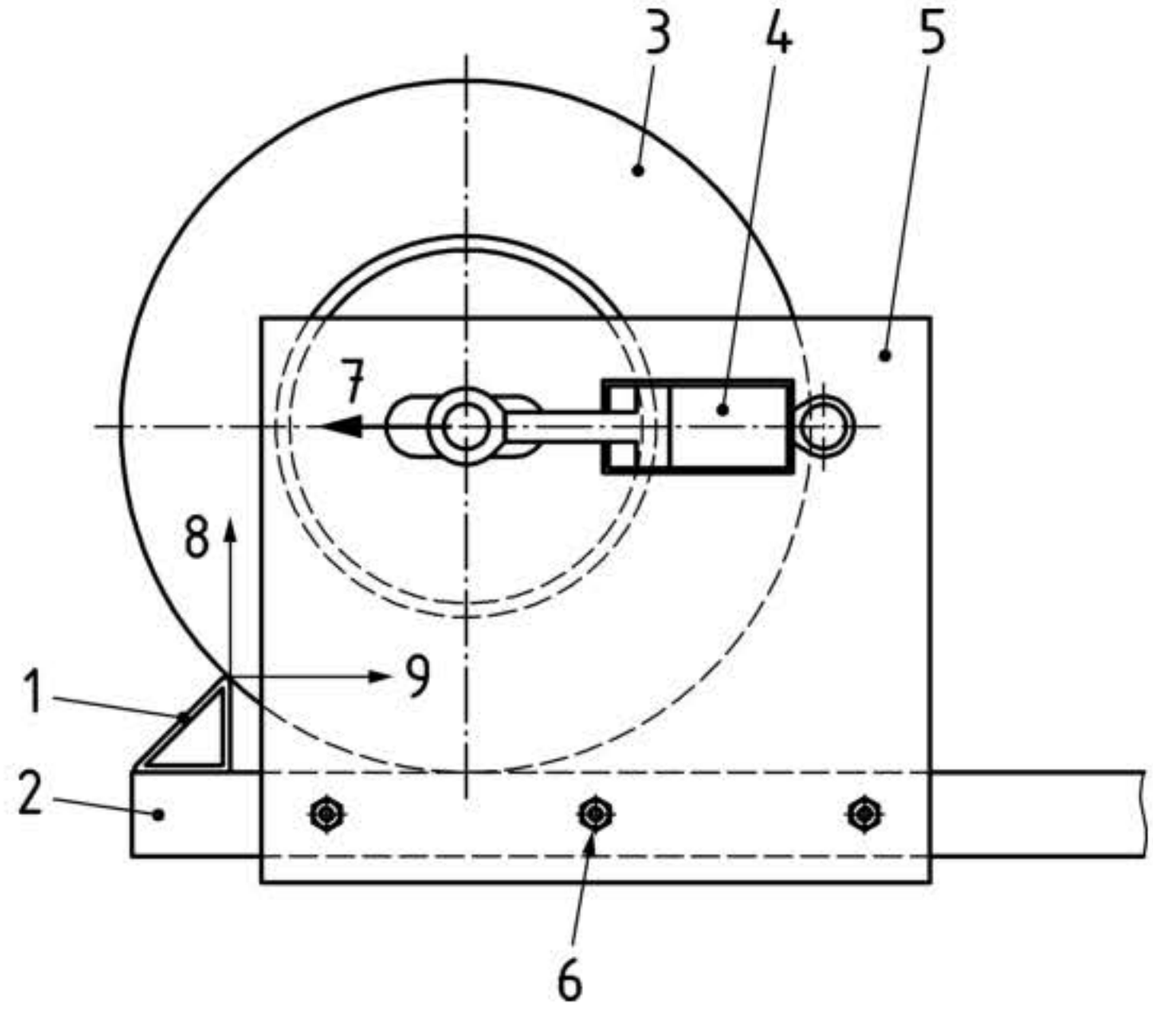
A horizontal force of twice the value as given in Table H.1 shall be initiated to the vehicle in the direction of travel. This could be done by means of e.g. a winch and a load cell with a valid calibration certificate. This shall be carried out 3 times for one minute each. Then the end stops shall be visually checked. There shall be no deformation or other damage.

b) With a testing device on 1 end stop.

Alternatively, the test can be carried out by means of a device as shown in Figure H.2.

Such a device shall be mounted on the platform in order to transfer the horizontal and vertical reaction forces to the platform by means of the support construction. The force, as given in the Table H.1, is initiated by means of (a) hydraulic cylinder(s) that is (are) attached to the axle of the wheel and to the support construction. The wheel can be a specially prepared standard wheel with the dimensions as given for the normative vehicle(s), or a manufactured geometry that has the same dimensions (width and radius) at the point of contact with the end stop.

The cylinder force shall be calculated from the piston area times the oil pressure. The oil pressure shall be readable from a pressure gauge with a valid calibration certificate.



Key

1 end stop
2 platform
3 wheel
4 hydraulic cylinder
5 support construction
6 support construction attached to platform
7 horizontal force
8 vertical reaction
9 horizontal reaction

Figure H.2 — Test device

The test shall be carried out for each different end stop. This shall be carried out 3 times for one minute each. Then the end stops shall be visually checked. There shall be no deformation or other damage.

NOTE Alternative test constructions leading to comparable results can be used.

Annex I
(normative)

Arm locking device proof test procedure

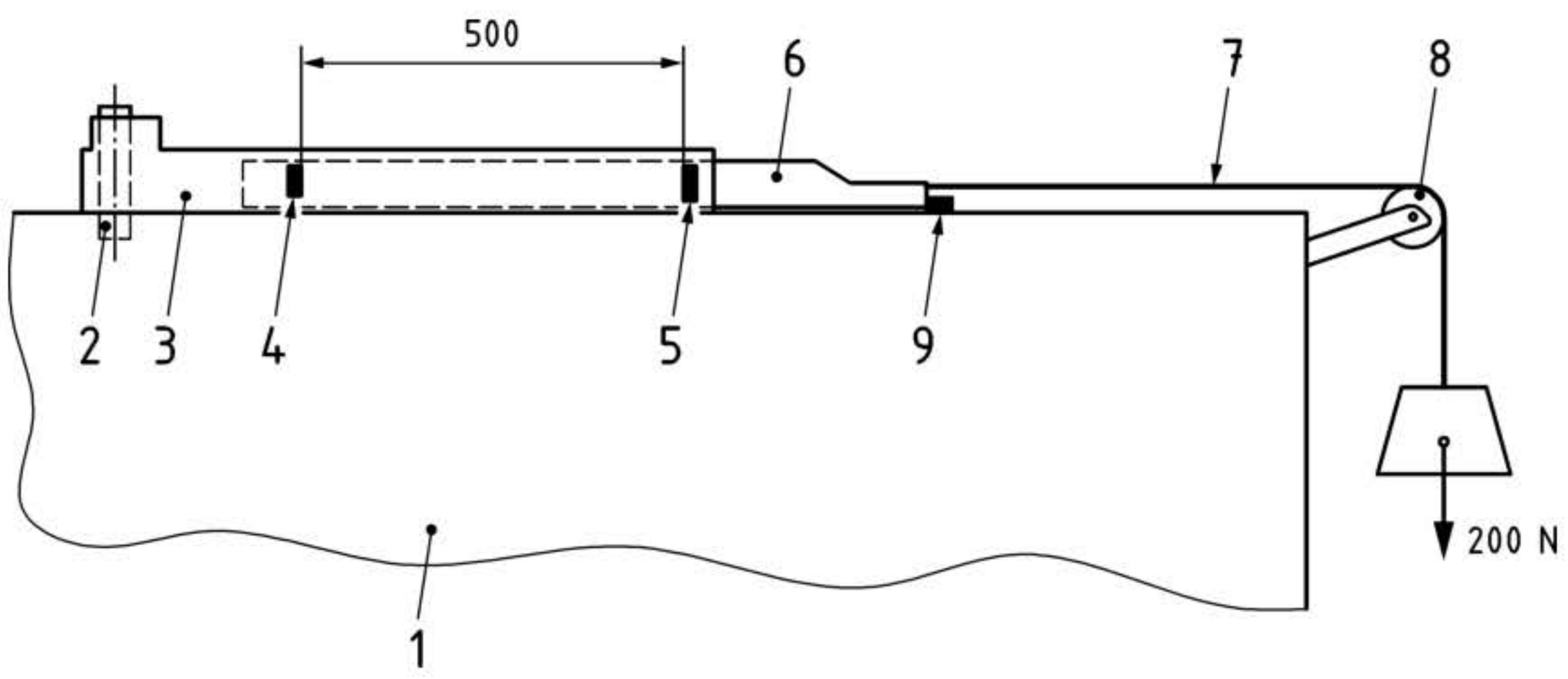
Apply at end of the arm fully extended a load F equal to 4,5 % of the rated load of the lift in the direction orthogonal to the arm itself, keeping the application of the load for at least 5 min.

The test is passed if the device still fulfils correctly its function after removing the force.

Annex J
(normative)

Test method for end stop of telescopic arms

The test shall be a dynamic test, based on multiple cycles conducted separately each single extension of the arm (see Figure J.1).



Key

1 horizontal support
2 means for fixing the arm to the horizontal support
3 fixed part of the arm
4 end stop device
5 mechanical stop
6 arm extension
7 rope
8 pulley
9 stop to be removed to start the test

Figure J.1 — Test method for end stop of telescopic arms

The test shall be performed under the following conditions:

— The arm shall be in a horizontal position.

— When testing the integrity of an arm extension end stop, the extension piece shall be set to move over its full travel if less than 500 mm and up to a maximum movement of 500 mm if longer.

— The extension shall be able to move smoothly inside the fixed part of the arm as expected in a new arm.

— A constant force of 200 N shall be applied to the outer end of the extension, in the direction aligned with the extension, until the movement of the extension itself stops by the action of end stop device.

— The force shall be applied 3 times for each extension.

— Then the end stop has to undergo a visual check: The test is passed if the system still fulfils its function after removing the force.

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