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English Version

Lifting platforms - Mast climbing work platforms

Matériels de mise à niveau - Plates-formes de travail se déplaçant le long de mât(s)

Hebebühnen - Mastgeführte Kletterbühnen

This European Standard was approved by CEN on 21 April 1997 and includes Corrigendum 1 issued by CEN on 11 December 1997, Amendment 1 approved by CEN on 1 September 2003 and Amendment 2 approved by CEN on 19 June 2009.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 1495:1997+A2:2009) 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of an identical text or by endorsement, at the latest by January 2010, and conflicting national standards shall be withdrawn at the latest by January 2010.

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This document supersedes EN 1495:1997.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ▌A1⟩ ⟨A1▌ and ▌A2⟩ ⟨A2▌.

The modifications of the related CEN Corrigendum have been implemented at the appropriate places in the text and are indicated by the tags ▌AC⟩ ⟨AC▌.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

▌A2⟩ For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A2▌

It is a type C- standard related to safety for Mast Climbing Work Platforms.

▌A2⟩ *deleted text* ⟨A2▌

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This standard is one of a series of standards produced by CEN/TC 98 as part of the CEN/CENELEC programme of work to produce machinery safety standards. EN 414 (Safety of machinery – Rules for the drafting and presentation of safety standards) has been used as a guide in the preparation of this standard.

This standard has been prepared to be a harmonized standard to provide one means of conforming with the essential safety requirements of the Machinery Directive.

The extent to which hazards are covered is indicated in the scope of this standard. In addition, lifting equipment shall comply as appropriate with [A1] EN ISO 12100 [A1] for hazards which are not covered by this standard.

1 Scope

1.1 This standard specifies the special safety requirements for Mast Climbing Work Platforms (MCWP) which are temporarily installed and are manually or power operated and which are designed to be used by one or more persons from which to carry out work. The vertical moving components (work platform) are also used to move those same persons and their equipment and materials to and from a single boarding point. These restrictions differentiate MCWPs from Builder's hoists.

The standard can also be used for permanently installed MCWP.

1.2 This standard is applicable to work platforms elevated by rack and pinion and guided by and moving along their supporting masts, where the masts may or may not require lateral restraint from separate supporting structures.

1.3 This standard is applicable to any combination of the following alternatives:

— One or more masts;

— Mast tied or untied;

— Mast of fixed or variable length;

— Masts vertical or inclined between 0° and 30° to the vertical;

— Masts which are standing or hanging;

— Movable or static base (chassis, or base frame);

— Manually or power operated elevation;

— Towed or self powered ground travel on site, excluding road traffic regulation requirements;

— Driven using electric, pneumatic or hydraulic motors.

1.4 This standard identifies the hazards arising during the various phases in the life of such equipment and describes methods for the elimination or reduction of these hazards and for the use of safe working practices.

1.5 This standard does not specify the requirements for dealing with the hazards involved in the manoeuvring, erection or dismantling, fixing or removing of any materials or equipment which are not part of the Mast Climbing Work Platform (MCWP). Neither does it deal with the handling of specific hazardous materials.

1.6 This standard does not specify the requirements for delivering persons and materials to fixed landing levels. Such equipment is referred to as lifts or hoists and are dealt with by other standards.

1.7 This standard does not include Mobile Elevating Work Platforms (MEWPs) according to ⟩A2⟨ EN 280 ⟩A2⟨, Suspended access equipment according to ⟩A2⟨ EN 1808 ⟩A2⟨ or Lifting tables according to ⟩A2⟨ EN 1570 ⟩A2⟨.

2 Normative references

⟩A2⟨ The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. ⟩A2⟨

⟩A2⟨ *deleted text* ⟩A2⟨

EN 294:1992, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

EN 349:1993, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 418:1992, *Safety of machinery — Emergency stop equipment, functional aspects – Principles for design*

EN 614-1:1995, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 953:1997, *Safety of Machinery — General requirements for the design and construction of guards (fixed, movable)*

EN 954-1:1996, *Safety of Machinery — Safety-related parts of control systems — Part 1: General principles for design*

EN 982:1996, *Safety of machinery — Safety requirements for fluid power systems and components — Hydraulics*

EN 60065:1993, *Safety requirements for mains operated electronic and related apparatus for household and similar general use*

EN 60204-1:1992, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

EN 60529:1992, *Degrees of protection provided by enclosures (IP code)*

EN 60947-5-1:1991, *Low-voltage switchgear and controlgear — Part 5: Control circuit devices and switching elements — Section 1: Electromechanical control circuit devices and switching elements*

⟩A2⟨ EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)* ⟩A2⟨

ISO 4301-1:1986, *Cranes and lifting appliances — Classification — Part 1: General*

ISO 4302:1989, *Cranes — Wind load assessment*

ISO 6336-1, *Calculation of load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors*

ISO 6336-2, *Calculation of load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting)*

ISO 6336-3, *Calculation of load capacity of spur and helical gears — Part 3: Calculation of tooth strength*

ISO 6336-5, *Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials*

ISO 8686-1:1989, *Cranes — Design principles for loads and load combinations — Part 1: General*

3 Definitions

For the purposes of this standard the following definitions apply:

NOTE The terms which are used in this standard, with reference to the definitions below, are indicated in figures 1 and 2.

3.1
rated load
the loads for which the MCWP has been designed for in normal operation as stated in the load diagram

3.2
load diagram
a notice displayed on the work platform showing the permitted number of persons and the weight and distribution of materials for the particular configuration

3.3
rated speed
the vertical or horizontal speed for which the MCWP has been designed

3.4
transfer
any horizontal movement of the MCWP from one position to another on the same working site

3.5
transfer condition
the configuration of the MCWP in which the MCWP is moved from one position to another on the same working site and any limitation on the weather and the load or persons on the MCWP

3.6
transport
any movement of the MCWP outside the boundaries of the working site

3.7
transport condition
the configuration of the MCWP in which the MCWP is moved outside the boundaries of the working site (for example road transport)

3.8
transfer and transport interlocks
any design features on the MCWP which prevent unsafe transfer or transportation

3.9
base frame
the part of the MCWP which provides support for the mast and elevating assembly

3.10
chassis
the part of the MCWP which provides mobility and support for the mast and elevating assembly

3.11
rail mounted chassis
a chassis designed to transmit horizontal as well as vertical forces to the ground via rails

3.12
outriggers
Supports at the base frame level used to maintain or increase the stability of the MCWP within specified conditions. They may also be used for levelling.

3.13
outrigger beam
that part of an outrigger assembly which moves in a substantially horizontal plane and may be powered or operated manually

3.14
mast
a structure that supports and guides the platform

3.15
mast, fixed length
a mast whose length is fixed and cannot be varied, even by the attachment of further mast sections

3.16
mast, variable length
a mast whose length can be varied by the attachment of successive lengths of prepared sections

3.17
guides
the parts of the mast, which provide guiding for the work platform

3.18
mast tie
the anchorage system used to provide lateral restraint to the mast from the building or other structure

3.19
work platform
The vertical travelling part of the installation upon which the persons, equipment and materials are carried and from which work is carried out. This is as opposed to the MCWP, which refers to the whole of the installation, *inter alia* work platform, mast, mast ties, base and chassis. The work platform includes the main platform and any platform extension.

3.20
available platform area
the area of the work platform measured at the work platform floor level

3.21
main platform
that part of the work platform which is built up using primary structural elements

3.22
platform extensions
those additional parts of the work platform which are built up using secondary structural elements, whose support and location is dependent upon the main platform. They are used to extend the main work platform, usually along its longitudinal working edge. They may form irregular shapes which conform to the work site. They may also extend at a level just above or below the main platform level.

3.23
multilevel work platforms
multilevel work platforms consist of two or more work platforms travelling on the same mast or an additional working level attached to and totally supported by a work platform. (For illustration see annex B)

3.24
counter roller
a roller used to counter – react the gear meshing separation forces between a rack and pinion

3.25
automatic brake
a device to decelerate and stop moving parts in case of interruption of the power supply

3.26
buffer
a resilient stop at the end of the travel, comprising a means of arresting using fluids, springs or similar means

3.27
overspeed
any speed above rated speed

3.28
safety gear
a mechanical device for stopping and maintaining the work platform stationary on the mast in the event of overspeed

3.29
overspeed governor
a device which, when the work platform attains a predetermined speed above rated speed, causes the safety gear to be applied

3.30
competent person
a person having such practical and theoretical knowledge and such experience of that MCWP as is necessary to carry out the function satisfactorily

3.31
user (user organisation)
the person or organisation which has direct control over the MCWP use

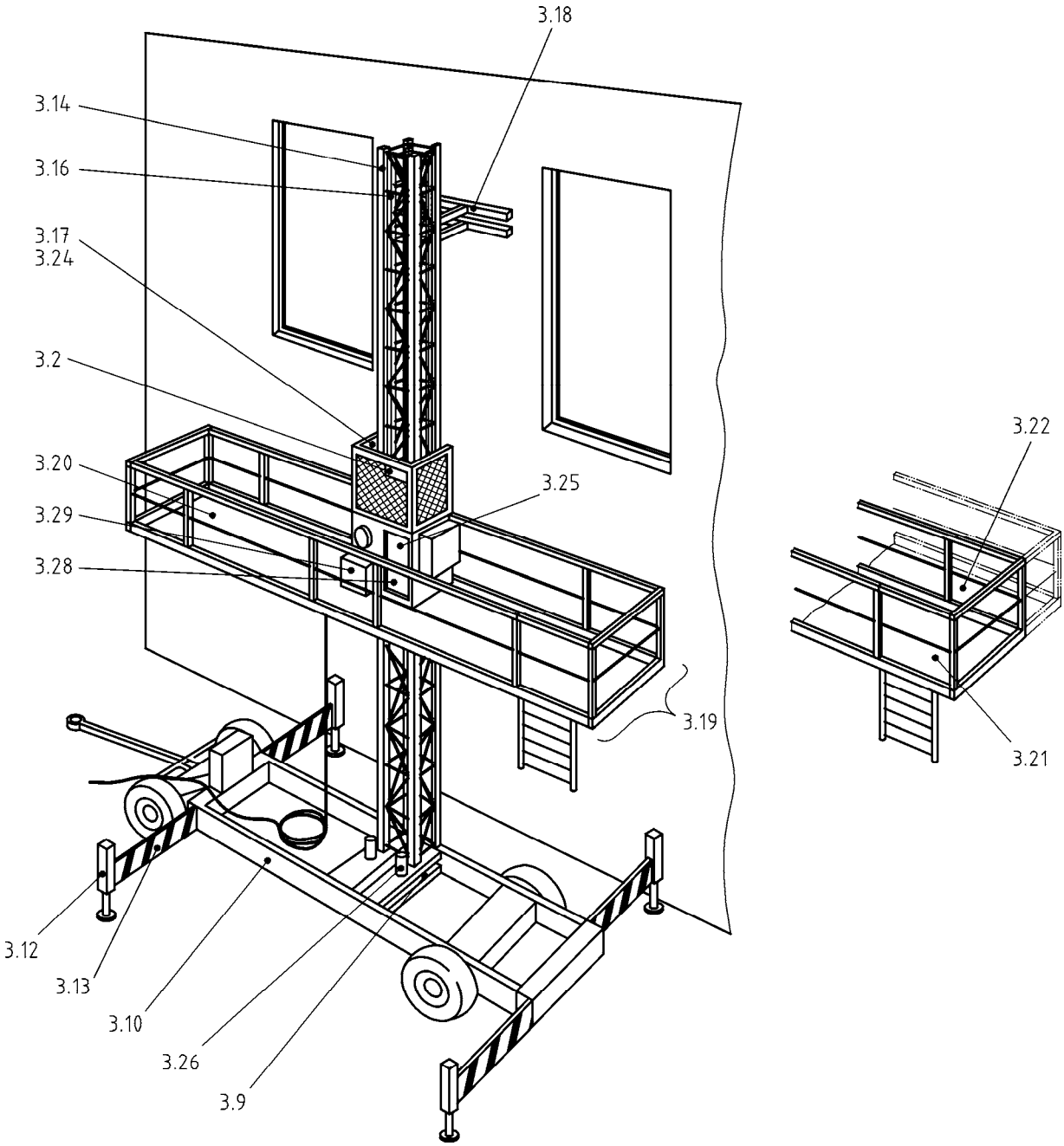


Figure 1 — Typical single mast MCWP

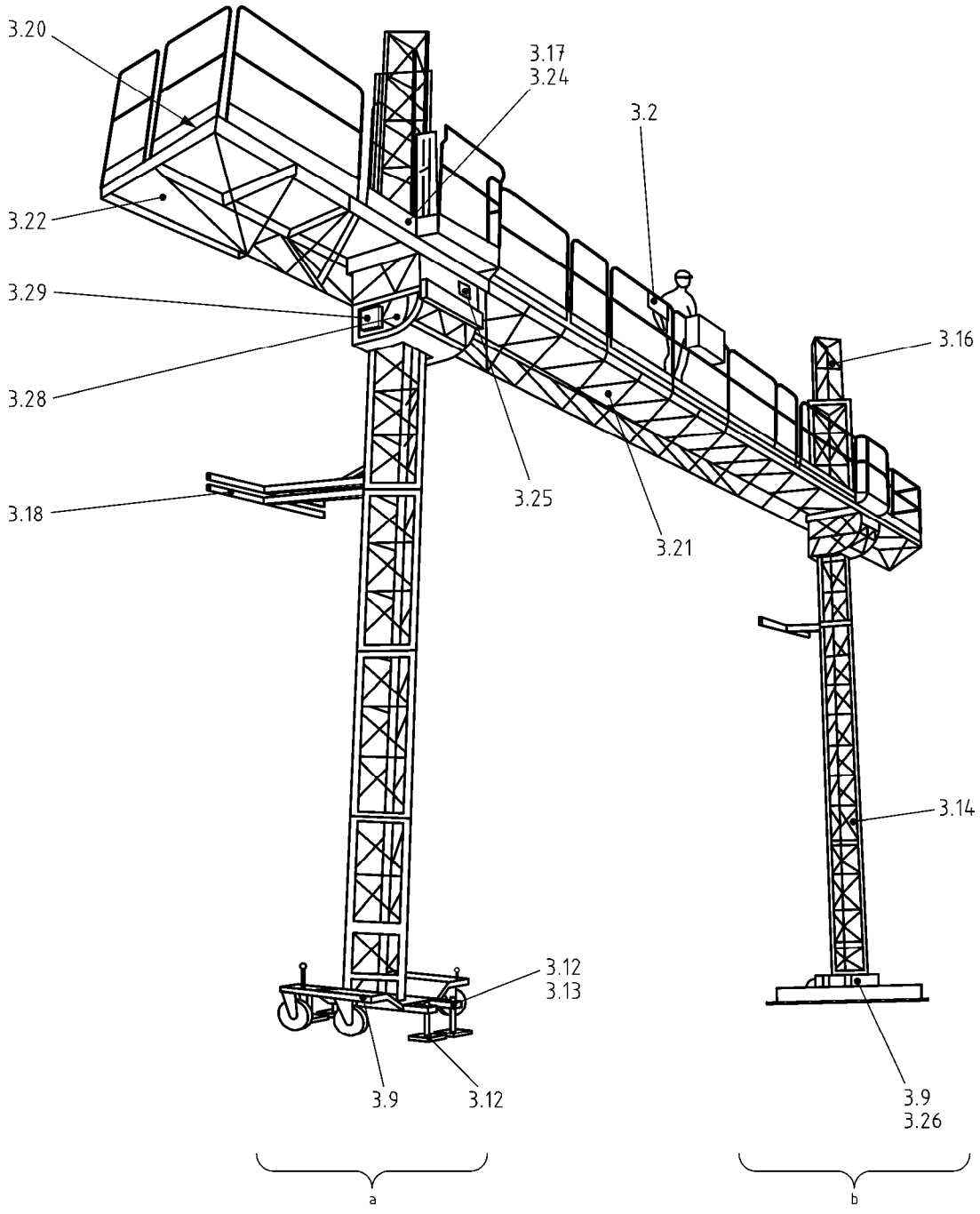


Figure 2 — Typical twin mast MCWP

4 List of hazards

The list of hazards according to the following tables are based on A2 EN ISO 12100 A2 and Directive 89/392/EEC as amended by 91/368/EEC and 93/44/EEC.

Tables 1.1, 1.2 and 1.3 show the hazards which have been identified and where the corresponding requirements have been formulated in this standard in order to limit the risk or reduce these hazards in each situation.

A hazard which is not applicable or is not significant and for which, therefore, no requirements are formulated, is shown in the relevant clauses column as NA (not applicable).

Table 1.1 — List of hazards (part 1)

	HAZARDS	RELEVANT CLAUSES IN THIS STANDARD
1	**Mechanical hazards (caused for example by:**	
1.1	Crushing	5.2.1.3; 5.3.2; 5.4.1
1.2	Shearing	5.2.1.3; 5.3.2; 5.4.1
1.3	Cutting or severing	5.3.2; 5.4.1
1.4	Entanglement	5.4.1
1.5	Drawing-in or trapping	5.2.1.3; 5.3.2; 5.4.1
1.6	Impact	5.4.4
1.7	Stabbing or puncture	NA
1.8	Friction or abrasion	NA
1.9	High pressure fluid ejection	5.9.7; 5.9.8; 5.9.9; 5.9.10
1.10	Ejection of parts	5.2.1.4; 5.2.1.5
1.11	Loss of stability	5.1.5; 5.2.2.4; 5.2.2.5
1.12	Slip, trip and fall	5.2.2.1; 5.3.1
2	**Electrical hazards**	
2.1	Electrical contact	5.8; 7.1.2.7
2.2	Electrostatic phenomena	NA
2.3	Thermal radiation	NA
2.4	External influences	5.7.15 Annex C
3	**Thermal hazards**	**Relevant but not dealt with**
4	Hazards generated by noise	**Relevant but not dealt with**
5	Hazards generated by vibration	5.1.2.3.2
6	Hazards generated by radiation	NA
7	Hazards generated by materials and substances processed, used or exhausted by machinery:	
7.1	Contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	5.9
7.2	Fire or explosion	NA
7.3	Biological and microbiological	NA
8	**Hazards generated by neglecting ergonomic principles in machine design:**	

(continued)

Table 1.1 — List of hazards (part 1) (concluded)

	HAZARDS	RELEVANT CLAUSES IN THIS STANDARD
8.1	Unhealthy postures or excessive efforts	5.2.1.6; 5.2.5.2; 5.6.2; 5.12; 5.12.8
8.2	Inadequate consideration of human hand/arm or foot/leg anatomy	NA
8.4	Inadequate area lighting	7.1.2.6
8.5	Mental overload or underload, stress	NA
8.6	Human error	5.2.2.1; 5.12
9	**Hazard combinations**	**5.1.1.1; 5.1.1.2; 5.1.3**
10	**Hazards caused by failure of energy supply, breaking down of machinery parts and other functional disorders**	**5.1**
10.1	Failure of energy supply	5.2.2.1; 5.6; 5.8.1.4; 5.12.7
10.2	Unexpected ejection of machine parts or fluids	5.9.7; 5.9.8; 5.9.9; 5.9.10
10.3	Failure or malfunction of control system	5.2.1.5
10.4	Errors of fitting	5.1.5.1.5
10.5	Overturn, unexpected loss of machine stability	5.1.1.2; 5.1.5; 5.7
11	**Hazards caused by missing and/or incorrectly positioned safety related measures/means**	
8.3	Neglected use of personal protection equipment	5.12.8; 7.1.2.7; 7.1.2.12
11.1	Guards	
11.2	Safety related (protection) devices	5.7
11.3	Starting and stopping devices	5.1.1; 5.3.4.9; 5.12
11.4	Safety signs and signals	5.2.2.7; 7.1.2.9
11.5	Information or warning devices	7.1.2.9
11.6	Energy supply disconnecting devices	5.2.1.2; 5.8.1.2
11.7	Emergency devices	5.5; 5.6
11.8	Feeding/removal means of workpieces	NA
11.9	Essential equipment and accessories for safe adjusting and/or maintaining	5.2.3.1; 5.4.2.10
11.10	Equipment evacuating gases	NA

Table 1.2 — List of hazards (part 2)

	HAZARDS	RELEVANT CLAUSES IN THIS STANDARD
12	**Inadequate lighting of moving/working area (continued)**	**7.1.2.6**
13	**Hazards due to sudden movement instability etc during handling**	**5.1.5; 5.2.2.1; 5.2.2.3; 5.2.2.4; 5.4.3**
14	**Inadequate/non-ergonomic design of operating position**	
14.1	Hazards due to dangerous environments (contact with moving parts, exhaust gases etc)	5.2.2
14.2	Inadequate visibility from operators position	5.12.2; 5.12.5
14.3	Inadequate seat/seating	NA
14.4	Inadequate/non-ergonomic design/positioning of controls	5.12
14.5	Starting/moving of self-propelled machinery	5.12
14.6	Road traffic of self-propelled machinery	7.1.2.6; 7.1.2.12
14.7	Movement of pedestrian controlled machinery	7.1.2.6; 7.1.2.12
15	**Mechanical hazards**	**5.1.1.1**
15.1	Hazards to exposed persons due to uncontrolled movement	5.2.2.1; 5.2.4; 5.3.1.5, 5.4.1; 7.1.2.7
15.2	Hazards due to break-up and/or ejection of parts	5.2.1.4; 5.2.1.5; 5.2.2.3
15.3	Hazards due to rolling over (ROPS)	5.1.5
15.4	Hazards due to falling objects (FOPS)	7.1.2.7
15.5	Inadequate means of access	5.3.3; 5.3.4
15.6	Hazards due to towing, coupling, connecting, transmission etc	5.2.2.6
15.7	Hazards due to batteries, fire, emissions etc	NA
16	**Hazards due to lifting operations**	
16.1	Lack of stability	5.1.5; 5.1.1.2; 5.2.2.4; 5.2.2.5; 5.2.5.1
16.2	Derailment of machinery	5.2.2.4; 5.4.1.5; 5.4.2
16.3	Loss of mechanical strength of machinery and lifting accessories	5.1; 5.2.1.7; 5.2.1.8; 5.2.2.2; 5.2.2.3; 5.2.3.2; 5.2.3.3; 5.2.5.2; 5.2.5.3; 5.3.1.4; 5.4.2; 5.4.3
16.4	Hazards caused by uncontrolled movement	5.2.2.5; 5.2.4; 5.4.1; 5.11
17	**Inadequate view of trajectories of the moving parts**	**5.12**
18	**Hazards caused by lightning**	**7.1.2**
19	**Hazards due to loading/overloading**	**5.7**

Table 1.3 — List of hazards (part 3)

Hazards according to the second amendment to the Machinery Directive involving the lifting of persons by MCWP.

	HAZARDS	RELEVANT CLAUSES IN THIS STANDARD
20	**Overloading or overcrowding of the carrier**	**5.1.2; 5.7; 5.10 Annex C**
21	**Unexpected movement of the carrier in response to external controls or other movements of the machine**	**5.12.7**
22	**Excess speed**	**5.4.1; 5.5; 5.6.3**
23	**Persons falling from the carrier**	**5.3**
24	**The carrier falling or overturning**	**5.2.2.3; 5.4.1; 5.5; 5.10; 5.11**
25	**Excess acceleration or braking of the carrier**	**5.2.2.4; 5.4.3.1.2; 5.4.4**
26	**Due to imprecise markings**	**5.2.2.7; 7.2**

5 Safety requirements and/or measures

5.1 Structural and stability calculations

5.1.1 General

5.1.1.1 All loads and forces which can occur in any allowed configuration during erection, operation, out-of-service, dismantling and transfer shall be considered. This shall also include inclined or hanging masts.

5.1.1.2 The manufacturer shall be responsible for:

— Stability calculations, in order to identify the various configurations of the MCWP and the combinations of loads and deflections, which together create conditions of instability;

— Structural calculations, to evaluate the individual forces and to make allowance for deflections. All combinations of forces shall be considered including those which produce the most unfavourable stresses in the components.

5.1.2 Loads and forces

The following loads and forces shall be taken into account:

5.1.2.1 Structural loads

The masses of the components of the MCWP when they are not moving are considered to be static structural loads.

The masses of the components of the MCWP when they are moving are considered to be dynamic structural loads.

5.1.2.2 Rated load

5.1.2.2.1 The rated load for design purposes is:

$m = (n \times m_p) + T + (2 \times m_e)$

where m = rated load (kg)

m_p = 80 kg; mass of each person

m_e = 40 kg; mass of personal equipment (for the first two persons only)

T = mass (kg) of material and equipment on the work platform (excluding personal equipment)

n = number of persons on the work platform

The mass of persons and the mass of equipment and material shall act simultaneously.

The minimum number of persons shall be:

Two (2) for single mast platforms and four (4) for multiple mast platforms.

The mass of the personal equipment (m_e) shall be assumed to act on the point coincident with each of the two persons which give the highest stresses.

5.1.2.2.2 The mass of each person is assumed to act as a point load on the MCWP at a horizontal distance 0,1 m from the upper inside edge of the top guard rail. The distance between the point loads shall be 0,5 m (see figure 3 as an example).

5.1.2.2.3 The mass T shall be evenly distributed over the whole area of the main platform giving a specific load per length t.

The centre of gravity of the mass T shall be assumed to act on a point 0,15 B (where B is the width of the main platform) away from the longitudinal centre line of the main platform, on the side giving the highest stresses. See figure 4.

Calculations must allow for the possibility that a reduced load giving an unbalanced loadcase may result in higher stresses in some parts of the MCWP than a balanced rated load case would give.

For single mast machines the bending moment, M, on masts and platforms shall be calculated according to formula 1, where L_{max} is the greater of the distances L_1 and L_2 in figure 5.

For multiple mast machines the bending moment M, on masts and platforms shall be calculated according to formulas 2, 3, 4 and figure 6. The factors 1,15 and 1,2 are used in the formulas 1, 2, 3, 4 in order to cover the situations in use where, instead of a uniformly distributed load, a concentration of the same load is placed elsewhere within that individual length.

Dimensions in metres

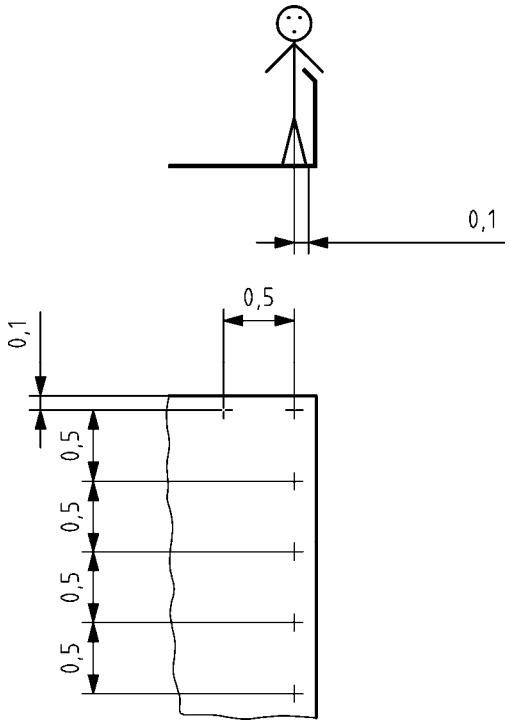


Figure 3 — Example of the distribution of persons on the main platform or platform extensions

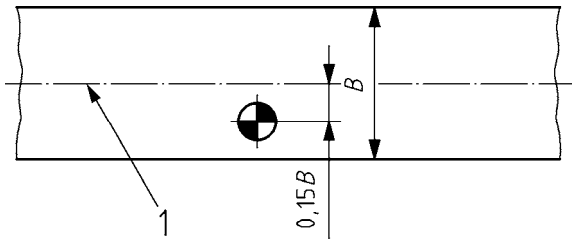
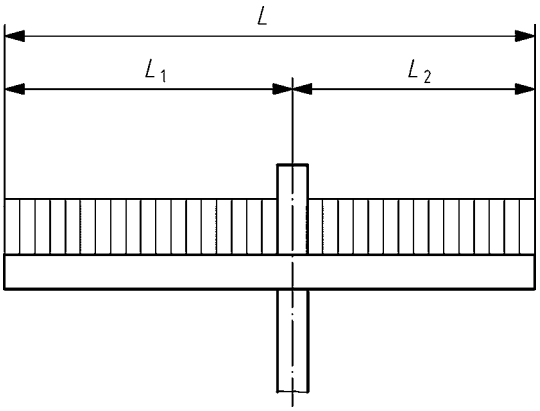


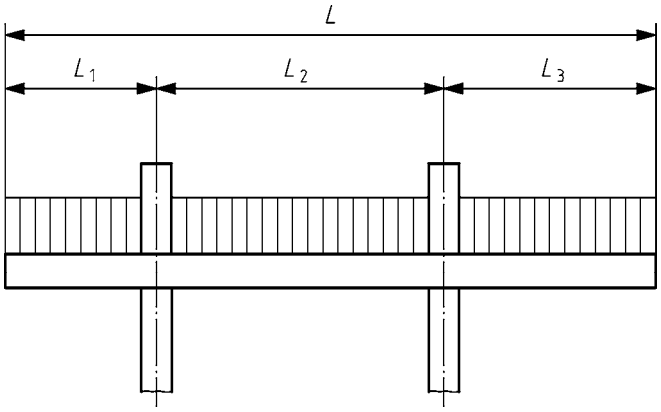
Figure 4 — Eccentric loading normal to the centre line



Specific load t = $\frac{T}{L}$

Formula (1): $M_{max} = \frac{t \times L_{max}^2 \times 1{,}15}{2}$

Figure 5 — Loading in the longitudinal direction. Single mast machines



Specific load t = $\frac{T}{L}$

Formulas:

(2) $M_1 = \frac{t \times L_1^2 \times 1{,}15}{2}$

(3) $M_2 = \frac{t \times L_2^2 \times 1{,}2}{8}$

(4) $M_3 = \frac{t \times L_3^2 \times 1{,}15}{2}$

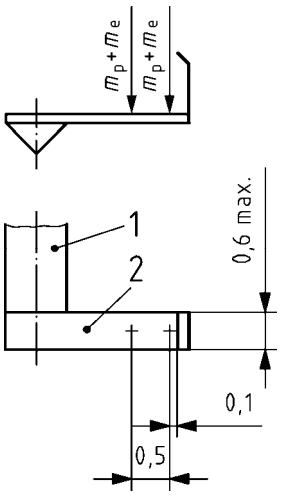
Figure 6 — Loading in the longitudinal direction. Multiple mast machines

5.1.2.2.4 If the area of the main platform, or part of it, is increased by means of extensions, usually to the longitudinal edge of the platform, the mass of the number of persons allowed on the platform, according to 5.1.2.2.1, shall be assumed to act on these longitudinal edges according to 5.1.2.2.2.

5.1.2.2.5 In order to provide long cantilever extensions of restricted width to reach more distant work points an exception to 5.1.2.2.4 may be made, but shall be clearly explained on a sign easily visible on that particular extension to the main platform. In no such case shall the load on the extension be calculated for less than two persons (m_p) carrying their personal equipment (m_e). In order to restrict the available platform extension area, such extensions shall not be more than 0,6 m wide. See Figure 7.

〈AC〉

Dimensions in metres



Key

1 main platform

2 platform-extension

Figure 7 — Long cantilever extensions 〈AC〉

5.1.2.2.6 Where the manufacturer includes in his design, provision for the use of a handling crane then the mass of the crane and the crane's rated load shall together be treated as part of the rated load of the MCWP. The location of the force resulting from the use of the crane shall be dictated by the manufacturer's chosen mounting positions for the crane supports.

5.1.2.3 Horizontal forces

5.1.2.3.1 Manual forces

The minimum value for the manual force is assumed to be 200 N for each of the first two persons on the platform and 100 N for each additional person permitted to be on the work platform.

It is assumed that the force is applied at a height of 1,1 m above the floor of the work platform and acts in a horizontal direction.

5.1.2.3.2 Forces from the use of power tools

Where the manufacturer of the MCWP permits the use of power tools which impose horizontal reaction forces on the work platform which are in excess of those given in 5.1.2.3.1 then the manufacturer shall specify the maximum force permitted. It is to be assumed that the force is applied at a minimum height of 1,1 m above the floor of the work platform.

Such forces may be caused by the use of, for example:

— Water jetting equipment;

— Sand or grit blasting equipment;

— Mechanically assisted drilling machine;

— Hammer assisted drill;

— Electrically driven hammer/breaker.

5.1.2.3.3 Forces from the use of weather protection screens on the Work Platform

If the Work Platform is designed to permit the use of weather protection, in the form of a roof over part of, or the whole of a work platform, then the resulting wind forces shall be considered to act on walls which reach the full height from the work platform floor to the top of the roof. Wind forces shall be calculated according to 5.1.2.5 and 5.1.2.8. For platform regions protected by such weather screens, the wind forces on persons, equipment and material coming under the protection of these weatherscreens may be neglected.

The mass of the weather protection screens shall be treated as part of the rated load.

5.1.2.4 Dynamic forces

Dynamic forces shall be taken into account by multiplying all moving masses by a dynamic factor of 1,15.

Moving, includes the raising and lowering of the work platform and also transfer of the MCWP in its transfer condition.

5.1.2.5 In service wind loads

5.1.2.5.1 All MCWP used out-of-doors or otherwise exposed to wind, whilst in service, shall be regarded as being affected by a minimum wind pressure in accordance with table 2.

Table 2 — Minimum design wind data, in service

Installation	Wind velocity [m/s]	Wind pressure [N/m^2]
Freestanding or MCWP during erection and dismantling	12,7	100
Tied MCWP	15,5	150

5.1.2.5.2 Wind forces are assumed to act horizontally at the centre of the wind area of the exposed structural parts of the MCWP.

5.1.2.5.3 The windforce coefficients applied to areas exposed to the wind shall be in accordance with ISO 4302. The windforce coefficient for persons exposed to the wind is 1,0.

5.1.2.5.4 The full area of one person is 0,7 m^2 (0,4 m average width $\times$ 1,75 m height) with the centre of area 1,0 m above the work platform floor.

5.1.2.5.5 The exposed area of one person standing on a work platform behind an imperforate section of fencing 1,1 m high is 0,35 m^2 with the centre of area 1,45 m above the work platform floor.

5.1.2.5.6 The number of persons directly exposed to the wind is calculated as:

a) The length of the side of the work platform exposed to the wind, rounded to the nearest 0,5 m and divided by 0,5 m, or

b) The number of persons allowed on the work platform if less than the number calculated in a).

5.1.2.5.7 If the number of persons permitted on the work platform is greater than in 5.1.2.5.6 a), a reducing coefficient of 0,6 may be applied to the extra number of persons.

5.1.2.5.8 The wind force on exposed equipment and material on the work platform is calculated as 3 % of the mass (T), acting horizontally at a height of 1,0 m above the work platform floor.

5.1.2.6 Loads and forces occurring during transfer conditions

Inertia forces plus any load permitted by the manufacturer on the work platform shall be taken into account when the MCWP is subject to transfer conditions.

5.1.2.7 Erection and dismantling loads

The load for which the MCWP has been designed during erection and dismantling. Erection load may be higher than rated load.

If the handling crane, as carried in 5.1.2.2.6, is used during erection and dismantling of the MCWP, then the crane's mass and the rated load shall together be treated as part of the erection load.

5.1.2.8 Out of service wind loads

Whilst out of service, with the work platform in a safe position, the wind pressure for the calculations shall be in accordance with table 3.

The limiting wind pressure shall be considered in the most unfavourable direction.

Table 3 — Design wind pressures, out of service

Height of member above ground level (m)	Wind Velocity (m/s)	Wind Pressure {N/m^2)
0 to 20	35,8	800
over 20 to 100	42	1100
over 100	45,9	1300
NOTE The wind values given in table 3 are minimum values for the central European area and at low altitudes. In special cases, e.g. coastal areas or at higher altitudes, information set out in specific national standards shall be used until relevant European standards are available.		

5.1.2.9 Buffer zones

Buffer forces shall be calculated taking into account the characteristics of the buffer.

5.1.2.10 Action of the safety means according to 5.5

To determine the forces produced by an operation of these means, the sum total of all travelling masses shall be multiplied by a factor of 2. A lower factor, but not less than 1,2 may be used if it can be verified by test under all conditions of loading up to 1,5 times the rated load.

5.1.2.11 Inaccuracies in setting up

For the purposes of calculation an allowance of an additional 0,5° shall be made to allow for user inaccuracy when erecting the mast.

5.1.3 Load combinations and safety factors

The load combinations to be taken into consideration shall be as follows:

Load combination A1: MCWP in service without wind, static.

Load combination A2: MCWP in service without wind, dynamic.

Load combination B1: MCWP in service with wind, static.

Load combination B2: MCWP in service with wind, dynamic.

Load combination B3: MCWP during erection or dismantling.

Load combination B4: MCWP during transfer condition.

Load combination C1: MCWP striking the buffer whilst in service.

Load combination C2: MCWP during action of the safety means whilst in service.

Load combination C3: MCWP out of service.

The above load combination references (A1, A2, B1, B2 etc) are used in Annex A (informative) as load case A, load case B and load case C as appropriate.

In each load combination the loads and forces acting on the MCWP shall be in accordance with table 4. Safety factors for structural steels and aluminium alloys are given in Table 5 and Table 6 respectively.

Table 4 — Load combinations that shall be taken into consideration

		Load combination								
Loads	**Ref. clause**	**A1**	**A2**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**
Structural loads	5.1.2.1	X	X	X	X	X	X	X	X	X
Rated load	5.1.2.2	X	X	X	X			X	X	
Horizontal forces	5.1.2.3	X		X						
Dynamic forces	5.1.2.4		X		X	X	X			
In service wind loads	5.1.2.5			X	X	X	X			
Loads and forces during transfer condition	5.1.2.6					X	X			
Erection and dismantling loads	5.1.2.7					X				
Out of service wind loads	5.1.2.8									X
Buffer forces	5.1.2.9							X		
Action of safety means	5.1.2.10								X	
Inaccuracies in setting up	5.1.2.11	X	X	X	X	X	X			

Table 5 — Safety factors for structural steels

Load case	**Safety factor**
A1, A2	1,5
B1, B2, B3, B4	1,33
C1, C2, C3	1,25

Table 6 — Safety factors for structural aluminium alloys

Load case	Safety factor
A1, A2	1,7
B1, B2, B3, B4	1,55
C1, C2, C3	1,4

5.1.4 Structural calculations

See Annex A (informative).

5.1.5 Stability calculations

5.1.5.1 Calculation of forces

5.1.5.1.1 Forces causing overturning moments shall, when created by structural masses, be multiplied by a factor of 1,1 and when created by rated loads be multiplied by a factor of 1,2. It must be remembered here that an inclination of mast from the vertical will result in an increasing overturning moment as the work platform travels upwards.

All forces causing stabilizing moments shall be multiplied by a factor of 1,0.

5.1.5.1.2 Wind forces shall be multiplied by a factor of 1,2 and assumed to be acting horizontally.

5.1.5.1.3 Horizontal forces as detailed in clause 5.1.2.3 shall be multiplied by a factor of 1,2 and assumed to be acting in the direction creating the greatest overturning moment.

5.1.5.1.4 Forces according to 5.1.2.6 shall be treated in the same way as specified in 5.1.5.1.1, 5.1.5.1.2 and 5.1.5.1.3 as appropriate.

5.1.5.1.5 Inaccuracies in setting-up according to 5.1.2.11 shall be taken into account in the stability calculation.

5.1.5.2 Calculation of overturning and stabilizing moments

5.1.5.2.1 The maximum overturning and corresponding stabilizing moments shall be calculated about the most unfavourable tipping lines.

The calculations shall be made with the MCWP in the most unfavourable configurations with the maximum allowable inclination of the chassis defined by the manufacturer. Every load and force combination including inaccuracy in setting-up shall be taken into account in their most unfavourable combinations.

In each case the calculated stabilizing moment shall be greater than the calculated overturning moment.

5.2 General machine requirements, base frame, chassis and mast

5.2.1 General machine requirements

5.2.1.1 The MCWP and all parts belonging to it shall be calculated in accordance with 5.1.

5.2.1.2 MCWP shall be equipped with a permanently installed device on the work platform to switch off the work platform and secure it against unauthorised use whilst out of service.

Similar devices shall be permanently installed at the chassis of self-propelled MCWP which isolates all movements of the MCWP.

Such devices shall be secured by a pad-lock or similar device.

5.2.1.3 Trapping and shearing points between the chassis and work platform shall be avoided by providing safe clearances or adequate guarding. See EN 349 and EN 953. ▌A1⟩ When it is foreseen (e.g. for maintenance) that the fixed guard will be removed regularly then the fastenings shall remain attached to the guard or to the machinery. ⟨A1▐

If safe clearance or adequate guarding is not possible, then an acoustic warning device shall be fitted to the work platform which at least gives a continuous warning when the work platform is moving within 2,5 m of the chassis.

Trapping, crushing and shearing points need only be considered at those areas within reach of persons on the work platform or standing adjacent to the MCWP at ground level, or at other points of access.

5.2.1.4 Locking pins shall be designed to be mechanically secured against unintentional disengagement and loss, e.g. split pin, locking nut whilst in position. In addition, they shall be provided with means to secure against unintentional loss when out of use e.g. captive chain.

5.2.1.5 Where compression springs are used for a safety function they shall be guided with secured ends. Their design shall be such that if they break then the parts cannot coil into each other.

5.2.1.6 The design of all components that have to be handled during erection e.g. mast sections, platform components, erection cranes, shall have their mass assessed against manual handling. Where the permissible mass for normal handling, is exceeded, the manufacturer shall give recommendations in the instruction handbook concerning suitable lifting equipment.

5.2.1.7 Attachment of lifting equipment

Where components are erected by means of lifting equipment, provision shall be made for adequate attachment of the lifting equipment. This shall ensure that the component is securely attached and lifted in the correct attitude for assembly.

5.2.1.8 Lifting equipment

Any dedicated lifting equipment shall be designed in accordance with ISO 8686-1 and ISO 4301-1 and shall not impose loads on the MCWP structure for which the MCWP was not designed.

5.2.2 Base frame and chassis

5.2.2.1 General

If chains or belts are used in drive systems, inadvertent movements of the chassis shall be automatically prevented if failure of a chain or belt occurs.

If powered and manual drive systems are provided for the same movement, interlocks shall prevent both systems from being engaged at the same time.

After failure of the power supply, no inadvertent movement shall occur.

Walkways on the base frame or chassis shall be equipped with a slip resistant surface.

5.2.2.2 Base frame

The base frame shall be equipped with fixings for safe and secure attachment of other parts of the construction such as mast and outriggers.

5.2.2.3 Chassis

The chassis shall be equipped with fixings for safe and secure attachment of other parts of the construction such as mast and outriggers.

Means shall be provided to ensure, or at least give proper warning, that the MCWP is in the proper transfer (or transport) condition.

If the platform must be locked at a position on the chassis during transport, then transport interlocks shall be provided.

Means shall be provided to prevent instability of the MCWP due to failure of any tyre of the chassis, for example by the provision of foam filled tyres or by giving instructions in the user manual regarding use of outriggers.

5.2.2.4 Drive to wheels (excluding road transport)

The chassis shall be capable of being stopped and held stationary with a braking device under all ground conditions and also the worst combination of horizontal speed and maximum gradient specified by the manufacturer. The brakes shall only be released and kept released by an intended action. Under all conditions the brake shall apply automatically. After being applied the means of braking shall not depend on an exhaustible energy source.

Acceleration and retardation must be within the manufacturer's stability criteria. It shall be possible to disengage the drive to the wheels before towing the MCWP.

For rail mounted chassis, means shall be provided to stop the machine safely at the limits of travel.

If axles are detachable, the chassis shall be equipped with fixings for safe and secure attachment of the axles when they are in use.

5.2.2.5 Outriggers

Outriggers shall be capable of carrying all loads permitted by the manufacturer. Max. allowable inclination and operation on the max. gradient permitted by the manufacturer shall also be considered.

The feet of the outriggers shall be designed to swivel in all directions by an amount equal to the maximum gradient specified by the manufacturer plus at least 10°.

A notice on the outriggers shall refer the user to the instruction handbook for information on the applied ground pressure resulting from the outrigger feet.

Movement of the outrigger beams shall be limited by mechanical stops. It shall also be possible to lock them at least in their extreme positions.

The outriggers shall be designed and manufactured so that unintentional movement is prevented.

Any hydraulic outrigger shall be equipped with a load holding valve, mounted directly to the cylinder. This valve, e.g. a pilot operated check valve or brake valve, shall prevent unintended flow of oil to or from the cylinder, even in case of pipe or hose rupture. The closing of this valve shall not cause a dangerous situation.

Power operated outriggers shall be fitted with a device to prevent power operated movement of the outriggers unless the work platform is in its intended position.

Outriggers relying on a permanent pneumatic pressure to provide support during use of the platform shall not be used.

Where central supports are provided directly beneath the masts these shall also comply with the relevant requirements of this clause.

5.2.2.6 Towbar

If towbars, when not in use, are left in a raised position, an automatic device shall be provided to hold the towbar in this position. Unintentional release shall not be possible.

Towbar and steering mechanisms shall be designed to prevent handling hazards to the user.

5.2.2.7 Warning marks

Outriggers, outrigger beams and other parts of the base frame or chassis protruding from the main outline of the platform shall be marked with warning colours.

5.2.3 Mast structure

5.2.3.1 General

Detailed examination of the rack and its means of attachment shall be possible without dismantling.

5.2.3.2 Racks

The racks shall be securely attached to the mast. Joints between adjacent sections of the rack shall be accurately aligned to avoid faulty meshing or damage to teeth.

5.2.3.3 Tie attachment points

If the MCWP is to be tied into a separate supporting structure the mast sections shall be designed to accommodate the attachment of ties at appropriate intervals. Attachment points shall be designed in accordance with 5.1.

5.2.3.4 Marking

All mast sections shall be marked with an individual identification or serial number enabling the date of manufacture to be determined.

5.2.4 Mast design with regard to erection

Effective means shall be provided to ensure, so far as practicable, that only correctly interchangeable mast sections can be connected together.

The design of the mast shall ensure effective load transfer between adjacent mast sections and that alignment is maintained.

Where the vertical members of the mast sections are used as guides for drive frame guide rollers the joints of adjacent sections shall provide a continuous path.

MCWP with masts which are tilted to the working position for use shall be equipped with a device to ensure that the mast is mechanically locked in the working position automatically. It shall not be possible to raise the work platform unless this lock is engaged.

5.2.5 Mast ties

5.2.5.1 General

MCWP's will require lateral restraint from an adjoining separate supporting structure when erected above the manufacturer's specified maximum free standing height. This restraint will normally be in the form of mast ties attached at intervals between the mast and the supporting structure.

5.2.5.2 Design

Mast ties shall be designed for manual handling and ease of assembly using hand tools and shall provide a degree of adjustment to accommodate tolerances between the MCWP mast and the supporting structure. They shall provide sufficient torsional rigidity to the mast.

5.2.5.3 Attachment to the supporting structure

The attachment of the mast ties to the supporting structure shall be designed to resist all forces generated, both in and out of service.

Sufficient information shall be provided in the instruction handbook to enable the forces applied to the supporting structure to be calculated.

5.3 Work platform

5.3.1 General

5.3.1.1 The work platform shall remain in a horizontal position within $\pm$ 2° during normal movements of the platform and under the application of the rated load and other forces exerted during normal operation. During operation of the means described in 5.5 and the emergency lowering/raising device in 5.6 the max permitted variation from horizontal shall be $\pm$ 5°.

5.3.1.2 Trapdoors in the work platform shall be securely fastened and shall not open downwards.

5.3.1.3 The floor material shall be slip-resistant. The floor shall be easy to clean and shall be self-draining. Any opening in the floor or between the floor and toeguards or access gates shall be dimensioned so as to prevent the passage of a sphere of 15 mm diameter. The floor material shall be securely fixed to the work platform. Any extensions shall be prepared for fixing of the floor material.

5.3.1.4 The work platform floor shall be designed to withstand without permanent deformation a static load of at least 200 kg exerted on the least favourable square area of 0,1 $\times$ 0,1 m.

5.3.1.5 Any telescopic extensions of the main platform shall be able to be secured to prevent their inadvertent movement. There shall be a clear indication of the maximum permitted extended position.

5.3.1.6 Platform extensions shall not be more than 0,5 m above or below the level of the main platform.

5.3.2 Guarding

[A1]

5.3.2.1 All sides of the main platform and any platform extension shall be designed to be equipped with a guardrail and toeboards which can be securely fastened in position.

5.3.2.2 With the exception of a side erected towards a wall (see 5.3.2.3 and Table 8), all sides of the platform or any extension shall be equipped with guardrails at least 1,1 m high with an intermediate guardrail not more than 0,5 m from the top guardrail or from the toeboard and toeboards 0,15 m high.

5.3.2.3 Guarding the side erected towards a wall depends on the horizontal distance (gap) between the platform and the wall. The following options shall be provided for use in accordance with 7.1.2.12 Figure 9 and Table 8.

1) 1,1 m high guardrail in accordance with 5.3.2.2;

2) 0,7 m high guardrail (without intermediate rail but with toeboard);

3) 0,15 m high toeboard.

5.3.2.4 The guardrails shall be constructed to withstand concentrated forces of 300 N for each person permitted on the platform, applied in the outwards horizontal direction at 0,5 m intervals.

The top of each guardrail shall also be constructed to withstand a single vertical load of 100 kg applied in the least favourable position but not simultaneously with the horizontal load. [/A1]

5.3.2.5 Chains or ropes shall not be used as guardrails.

5.3.2.6 Those sides of the main platform and any extensions immediately adjacent to the mast shall be protected to a height of at least 2 m to prevent access to the mast. Apertures shall comply with EN 294.

5.3.2.7 If extensions of the work platform are positioned between the mast and the building, then means shall be provided to prevent travel of the work platform with the extension in place.

5.3.2.8 Where the platform extension is not flush with the main platform, the unprotected opening between the two levels shall be guarded at least with a toeboard of 0,15 m height located on the lower level.

[A2]

5.3.2.9 When it is foreseen (e.g. maintenance) that the fixed guard rails will be removed regularly then the fastenings shall remain attached to the guard rail segments or to the platform. [/A2]

5.3.3 Access

5.3.3.1 At least one access gate shall be provided and it shall not open outwards. All access gates shall be so constructed as to either close automatically or be electrically interlocked to prevent operation of the work platform unless they are closed. Inadvertent opening of the access gate shall not be possible. Chains or ropes shall not be used as access gates.

5.3.3.2 When the distance between the access level and the floor of the work platform in the access position exceeds 0,5 m, the MCWP shall be equipped with an access ladder or stairs symmetrical with the access gate. The steps or rungs shall be divided equally over the distance between the access level and the floor of the work platform and in no case shall the step rise be more than 0,3 m.

The front of the steps or rungs shall be located to give at least 0,15 toe clearance.

5.3.3.3 Handholds, handrails or similar adequate devices shall be provided to facilitate climbing the access ladder to the work platform.

5.3.4 Multilevel work platforms

5.3.4.1 For multilevel work platforms the special requirements as set down in Annex B for options A and B shall be taken into account. In addition the following shall apply.

5.3.4.2 All additional components that are used with multilevel MCWP shall be calculated according to 5.1.

All additional forces imposed upon the main platform and the mast structure shall be calculated according to 5.1.

5.3.4.3 Guarding shall be in accordance with 5.3.2

5.3.4.4 Roof protection shall be arranged for the lowest platform in option B to protect persons from falling objects.

The roof construction for the lowest platform shall:

— Be designed to withstand a load of 100 kg distributed on any area 0,1 m $\times$ 0,1 m

— Be designed so as to prevent the passage of a sphere of 15 mm diameter.

5.3.4.5 In option A the two work platforms shall not be separated by more than 3 m between platform floor levels.

5.3.4.6 The separation distance between work platforms in option B shall be controlled by safety contact switches. This distance shall not be less than 2,5 m in normal operation taking into account levelling inaccuracies.

5.3.4.7 Ladders for option A shall comply with 5.3.3. Fixed access between the two work platforms shall be provided within the platform guarded area. Trapdoors shall comply with 5.3.1.2.

For option B direct access between work platforms shall not be provided.

5.3.4.8 For option A with multiple mast applications, platform levelling shall be in accordance with 5.3.1.1. The design shall ensure that clearance remains between the subsidiary work platform and the mast over the full levelling range.

5.3.4.9 Controls shall be in accordance with 5.12.

5.3.4.10 Buffers shall be in accordance with 5.4.4. For option A where the subsidiary work platform is located below the primary work platform, the height of the buffer shall be increased in order to act on the primary work platform.

5.3.4.11 For option A travel limit switches shall be in accordance with 5.11 taking into account the position of the subsidiary work platform.

For option B separate travel limit switches shall be provided for each work platform, all in accordance with 5.11 making allowance for the separation distance required in 5.3.4.6.

5.4 Drive systems for elevation

5.4.1 General

5.4.1.1 The maximum rated speed when raising and lowering the platform shall be no more than 0,2 m/s.

5.4.1.2 Fixed guarding shall be provided to prevent the entry of any material that might cause damage to any part of the drive system and to protect persons from injury. [A2] When it is foreseen (e.g. for maintenance) that the fixed guard will be removed regularly then the fastenings shall remain attached to the guard or to the machinery. [A2]

5.4.1.3 Chains or belts shall only be used in drive mechanisms in conjunction with an electrical safety device which stops the work platform and keeps it stopped as soon as failure of a chain or belt occurs.

5.4.1.4 Manual drive systems shall be designed and constructed to prevent kick-back of handles.

5.4.1.5 Measures shall be taken to prevent the uppermost guide rollers or shoes running off the top of the guides during normal operation. Further measures shall be taken to ensure that under no circumstances including erection and dismantling, can any safety device pinion come out of mesh with the rack.

5.4.1.6 Measures shall be taken to ensure the continued stability of the work platform in the case of failure of any guide roller.

5.4.1.7 Any hydraulic drive shall conform to EN 982. In addition the applicable requirements in 5.9 shall apply.

5.4.2 Rack and pinion system

5.4.2.1 Means shall be provided to maintain the rack and the driving or any safety gear pinion constantly in mesh under all conditions of load. Such means shall not rely upon the platform guide rollers. The devices used shall restrict movement of the pinion on its axis such that at least two-thirds of the tooth is always in engagement with the rack.

5.4.2.2 In addition it shall not be possible for the pinion to move out of its correct engagement with the rack by more than one third of the tooth height, even in the event of failure of a counter roller or other mesh control feature or local bending or deflection of the mast.

5.4.2.3 The rack and pinion tooth model shall not be less than

— Four (4) for drive systems where the counter roller or other mesh control feature reacts directly on the rack without the interposition of any other mast profiles.

— Six (6) where the reaction of the counter roller or other mesh control feature is by means of another element of the mast which is then in immediate contact with the rack.

5.4.2.4 Any safety gear pinion shall be situated lower than the drive pinions.

5.4.2.5 The drive pinion shall be designed according to ISO 6336, regarding tooth-strength, for a minimum of 10^8 load-cycles. The pinion shall be so dimensioned that, based on ISO 6336-5, there shall exist a minimum safety factor of 1,5 for tooth-strength taking into account the actual stress induced in the teeth under the total suspended static load per pinion.

5.4.2.6 The rack shall be made from material having properties matching those of the pinion in terms of wear and shall be designed according to ISO 6336, regarding tooth-strength, for a minimum of 10^4 load-cycles representing static strength.

The rack shall be so dimensioned that based on ISO 6336-5, there shall exist a minimum safety factor of 1,5 for tooth-strength for the actual stress induced in the teeth.

5.4.2.7 When more than one drive pinion is meshing with the rack, it shall only be permissible to share the design loads between the pinions, if a self-adjusting measure is provided to guarantee load sharing under all normal running conditions.

For drive systems according to 5.5.1.1 b) load sharing shall be neglected, and calculation of the rack and the pinion shall be in accordance with 5.5.3 g).

5.4.2.8 A pinion shall never be used as a guide roller.

5.4.2.9 Visual examination of all the pinions shall be possible without removal of the pinions or major disassembly of structural components of the MCWP.

5.4.3 Braking systems

5.4.3.1 General requirements

5.4.3.1.1 Every work platform shall be provided with a brake system which operates automatically:

a) In the event of loss of the main power supply;

b) In the event of loss of the supply to control circuits.

If two or more masts are used there shall be a braking ability for each mast.

The braking system shall have at least one electro-mechanical brake (friction type) or hydro-mechanical brake, but may, in addition, have other braking means (e.g. electric).

Belts or chains for coupling the drive pinion to the component on which the brake operates are not permitted.

5.4.3.1.2 The brake(s) on its own shall be capable of stopping the platform, travelling at rated speed and with 1,25 times the rated load with a retardation between 0,2 and 1,0 g. In addition the brake(s) on its own shall be capable of stopping the machine when travelling at the triggering speed of the overspeed governor with the rated load.

5.4.3.1.3 In the case of only one brake, all the mechanical components of the brake which take part in the application of the braking action on the drum or disc or drive pinion shall be constructed and installed in such a way that if a failure in one of them occurs sufficient braking shall remain to bring the work platform with rated load to a stop.

5.4.3.1.4 The components on which the brake operates shall be positively coupled to a sprocket or drive pinion.

5.4.3.1.5 Any machine fitted with an emergency lowering or raising device according to 5.6 shall be capable of having the brake released manually and require a constant effort to keep the brake open.

5.4.3.1.6 The action of the brake shall be exerted by compression springs. The springs shall be adequately supported and shall not be stressed in excess of 80 % of the torsional elastic limit of the material.

5.4.3.1.7 Brake blocks and linings shall be of incombustible material (the use of asbestos is forbidden) and shall be so secured that normal wear does not weaken their fixings.

Brakes shall be provided with means of adjustment.

Brake blocks and linings shall be protected against ingress of lubricants, water, dust or other contaminants to at least IP 23 (see EN 60529).

5.4.3.1.8 Band brakes shall not be used.

5.4.3.2 Special requirements for electro-mechanical brakes

5.4.3.2.1 In normal operation, a continuous flow of current shall be required to hold off the brake.

The interruption of this current shall be effected by at least two independent electrical devices, whether or not integral with those which cause interruption of the power supply of the drive motor.

If, when the work platform is stationary, one of the contactors has not opened the main contacts, further movement shall be prevented at the latest at the next change in the direction of motion.

5.4.3.2.2 When the motor of the work platform is likely to function as a generator, it shall not be possible for the electric device operating the brake to be fed by the driving motor.

Braking shall become effective without delay after opening of the brake release circuit (the use of a diode or capacitor connected directly to the terminals of the brake coils shall not be considered as a means of delay).

5.4.3.3 Special requirements for hydro-mechanical brakes

5.4.3.3.1 In normal operation a continuous oil pressure shall be required to hold off the brake.

5.4.3.3.2 When the motion of the platform is initiated, the brake shall not reach the hold off position before the normal operating torque for the drive is attained.

5.4.4 Buffers

5.4.4.1 MCWP shall be provided with buffers at the bottom limit of the travel of the work platform.

5.4.4.2 The total possible stroke of the buffer(s) shall be at least equal to the stopping distance corresponding with, the work platform with rated load, being arrested by the buffers from its maximum possible speed at a deceleration of 1,0 g. The maximum possible speed to be considered shall be that which can occur in service or the tripping speed of the overspeed governor whichever is the greater.

5.4.4.3 If the buffers travel with the work platform they shall strike against a clearly recognizable pedestal.

5.5 Means to prevent the work platform from falling with overspeed

5.5.1 General

5.5.1.1 All MCWPs shall be equipped with a device, or means which prevents the work platform from falling in the event of any failure (other than a structural failure of the mast/work platform) and which operates before a speed of 0,5 m/s is exceeded. This device, or means, shall automatically arrest and sustain the work platform with 1,1 $\times$ the rated load.

These devices or means shall, when tripped, cause a deceleration not less than 0,05 g and not more than 1,0 g.

This shall be achieved by one of the following systems:

a) A safety gear;

or

b) Two or more independent and identical electric motor direct drive units fitted to each mast.

5.5.1.2 Adjustable components which have a safety related function shall either require tools for their adjustment or be capable of being sealed against unauthorised adjustment.

5.5.1.3 These devices or means shall be designed to ensure that environmental conditions cannot affect their safe operation.

5.5.2 Safety gear and overspeed governor

5.5.2.1 Safety gear

The safety gear specified in 5.5.1.1 a) shall:

a) Be independent of the drive machinery other than the rack;

b) Be always fully operational in normal use, erecting, maintenance and dismantling;

c) Not be dependent on energizing or maintaining an electrical or other auxiliary circuit;

d) Be accessible for inspection, maintenance and testing without major dismantling;

e) Be designed using a safety factor of 2,5 based on the ultimate strength of the material and the highest force which can occur in the device with rated load and max. possible speed (see 5.5.1.1);

f) Be able to be tested by a competent person remote from the work platform so that persons are not exposed to danger;

g) Not use any part of the safety gear for guidance of the work platform;

h) Positively actuate on the masts or racks and shall be tripped by an overspeed governor (see 5.5.2.2);

i) Be designed so that all control circuits for normal operation will be automatically interrupted by a safety switch before or at the time the safety gear is applied;

j) Be designed so that the method of release of the safety device will require the intervention of a competent person in order to return the MCWP to normal operation;

k) Be designed such that the braking effect of the safety gear shall increase progressively from the point of tripping of the overspeed governor to the point of bringing the platform to rest.

5.5.2.2 Overspeed governor

5.5.2.2.1 The overspeed governor shall trip at a speed defined by the manufacturer, but in no case shall the work platform exceed the speed stated in 5.5.1.1.

5.5.2.2.2 Overspeed governors shall operate mechanically and shall either be driven by the safety gear pinion or by rope.

5.5.2.2.3 If ropes and pulleys are used for overspeed governors

— The rope diameter shall not be less than 6 mm;

— The ratio between the diameters of the ropes and the rope pulleys shall not be less than 20;

— The ratio between the highest pull force which could occur in the rope and the minimum breaking force of the rope shall not be less than 8;

— The minimum generated force shall not be less than 300 N and not less than twice the force necessary to engage the safety gear.

5.5.3 System involving two or more drive units fitted to each mast

The system specified in 5.5.1.1 b) shall:

a) Have at least 2 drive units fitted to each mast where each drive unit shall have its own brake, with each brake unit being completely independent and each being positively but separately connected to the rack and pinion system.

b) Be such that each brake on its own shall be capable of stopping and sustaining the work platform when carrying 1,1 $\times$ rated load, from the max possible speed even under emergency lowering conditions (see 5.6);

c) Be always fully operational in normal use, erection, maintenance and dismantling;

d) Be able to be tested by a competent person such that each individual brake can be tested separately;

e) Be accessible for inspection, maintenance and functional testing of the system without major dismantling;

f) When activated, interrupt automatically the control circuit for normal use;

g) Have each drive unit designed using a safety factor of 2,5 based on the ultimate strength of the material and the highest force which can occur in the drive with rated load and max. possible speed;

h) Be designed and manufactured in accordance with 5.10 where appropriate;

i) Detect malfunctions in each drive unit which endanger proper function. These shall at least indicate a loss of mechanical integrity which results in a differential in the current demand between each drive unit, exceeding 25 % of the full load current;

j) Have each individual drive unit fitted with a mechanical device that automatically prevents the work platform exceeding 0,4 m/s descent speed. Each such speed limiting device, when acting on its own, shall be capable of carrying the work platform and its rated load in the most disadvantageous configuration. Each device shall also be designed using a safety factor of at least 2,5 based on the basic ultimate strength of the material and the highest force which can occur.

5.6 Means for emergency lowering and raising the work platform

5.6.1 The MCWP shall be fitted with means which permit the manually controlled emergency lowering of the work platform under certain circumstances. Such circumstances shall include electrical failures but may exclude those mechanical failures which would prevent the safe movement of the work platform.

It is intended that such means shall offer the possibility of the emergency lowering of the work platform such that persons can leave it, dependent upon suitable site conditions being available.

5.6.2 The means shall:

a) Be operated from a safe, but easily accessible location on the work platform which also permits the best possible view of the travel area;

b) Have controls which are adequately shrouded or otherwise arranged to prevent, as far as possible, accidental operation from any cause;

c) Only be operable by a hold-to-run control which permits lowering of the work platform only as long as the control is manually held in a set position;

d) The manual force required on the control shall be no more than 400 N;

e) Require the temporary release of the braking system (see 5.4.3);

f) Permit the immediate automatic re-application of the braking system upon release of the emergency lowering controls;

g) Permit lowering whilst the work platform is carrying 1,1 $\times$ rated load;

h) Allow that no part of the work platform shall exceed $\pm$ 5° from the horizontal, according to 5.3.1.1 during emergency lowering.

5.6.3 The emergency lowering means shall not prevent the operation of the devices according to 5.5.1.1 a) and 5.5.3 j);

5.6.4 Means for emergency raising of the work platform may be fitted in addition to the means for emergency lowering. When fitted, the emergency raising means shall comply with 5.6.1 as well as 5.6.3 with the word raising substituted for lowering in all cases.

5.7 Overload/moment device

5.7.1 The MCWP shall be provided with an overload and moment detecting and indicating device. For exception see 5.7.16.

5.7.2 This device shall detect the total load due to persons, equipment and materials on the work platform. It shall also detect those moments due to these loads, that are likely to lead to overturning or failure of the MCWP. This device shall at least detect:

— Bending and torque moments on cantilevered main platforms;

— Bending and torque moments on the central part of simply supported main platforms;

— Bending moment on the mast.

5.7.3 Overload moment detection device shall be carried out at least whilst the work platform is stationary.

5.7.4 The overload/moment detector shall be consistent with the rated loads and their location shown or described on the rated load chart(s) for the MCWP.

5.7.5 The load and moment detection and indication shall function

a) Automatically for the different possible platform configurations;

or

b) If automatic detection and indication are not possible for different configurations, then a work platform configuration selector shall be provided which allows a clear classification of the chosen setting in comparison with actual work platform configuration. This can be done by either:

   1) A clear sign of the respective platform configuration

      or

   2) A code at each setting. In this case a clear reference shall be given to the explanation of the code on a separate code or configuration sign.

5.7.6 The number of possible selections permitting use of the work platform shall not exceed the number of configurations for the work platform.

5.7.7 The selector shall be so situated or protected so as to be inaccessible to unauthorised persons.

5.7.8 The overload/moment detector shall be triggered before reaching a load/moment of 1,1 x rated load/moment and once triggered shall continuously isolate the controls concerned until the overload/moment has been removed.

5.7.9 The design and installation of overload/moment detectors and indicators shall take into account the need to test the MCWP with overloads without dismantling and without affecting the performance of the detector or indicator.

5.7.10 The overload/moment indicator shall continuously, visually and audibly, warn the operator and other persons in the vicinity of the work platform when the overload/moment detector is activated.

5.7.11 No provision shall be made for the user to cancel the warning.

5.7.12 Visual warnings shall be positioned to be in full view of persons on the work platform.

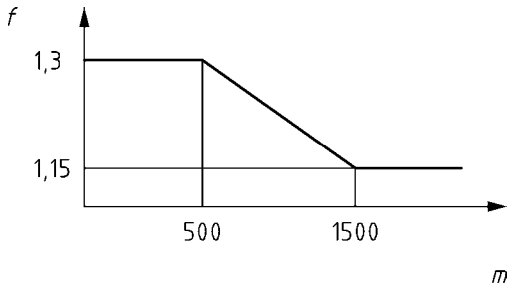
5.7.13 The overload/moment detector and indicator shall be arranged so that their operation (but not necessarily their accuracy) can be checked without applying loads to the work platform.

5.7.14 The overload/moment detector and indicator shall comply with 5.10.

5.7.15 The electrical and electronic requirements for overload detection devices are given in Annex C.

5.7.16 Devices according to 5.7.1 to 5.7.15 are not required if the following demands are met:

All design calculations shall be based on the loads m_p, m_e and T that are related to the rated load 'm' in 5.1.2.2.1 increased by a further factor f as a function of 'm' according to figure 8.



Key

f factor

m rated load in kg

Figure 8

Brakes and safety devices/means shall be calculated with the same loads as mentioned in the first paragraph.

For stability calculations the increased loads shall be considered in case they give overturning moments.

5.8 Electrical systems

5.8.1 General

5.8.1.1 Electrical and electronic installations and their appliances shall be in accordance with EN 60204-1, which applies in full.

5.8.1.2 At the chassis or base there shall be mounted a main switch according to EN 60204-1 at an easily accessible position.

5.8.1.3 Any drive system shall have, within a distance of not more than 2 m from the drive, a supply disconnecting device able to separate the energy supply from the drive in all poles of phases.

5.8.1.4 Safety and control circuits shall be in accordance with EN 60204-1. The safety and control circuits shall be electrically separated from all other circuits.

5.8.1.5 Transformers shall be used for supplying control circuits. Such transformers shall have separate winding and one side of the control circuit shall be connected to the protective bonding circuit (PE) (see 8.4 and 9.1.1 of EN 60204-1:1992).

5.8.1.6 All safety contacts shall be of positive opening operation type complying with the requirements of EN 60947-5-1.

5.8.1.7 In the event of a failure of one phase of the supply to the directional control device, the machine shall stop.

5.8.1.8 Precautions shall be taken to ensure the free and safe movement of any trailing cable throughout the full range of travel of the work platform. Where the mast is inclined or where multilevel work platforms to option B (annex B) are used, additional precautions are necessary, for example by making the cable follow the incline of the mast by the use of guides or the use of automatic cable reeling drums.

5.8.2 Safety switches

The operation of a safety switch shall be by positive separation of the contacts, even if the contacts have been welded together. Safety switches shall comply with 5.8.1.6 and the conditions set out in table 7 below.

Table 7 — Conditions for use of electric switches

Clause	Devices checked	Switch	EN 954-1 Category of control system
5.3.4.6	Separation distance switch	sc	1
5.5.2.1 i)	Operation of overspeed safety devices	sc	1
5.11.1	Terminal stopping switch	ssr	B
5.11.2	Final limit switch	sc	1
Abbreviations: ssr = safety switch, self-resetting sc = safety switch in a safety circuit			

5.8.3 Control system

The control system shall comply with EN 954-1 category 1 unless otherwise stated in table 7. This includes any control system using electrical or hydraulic power.

In redundancy-type circuits and diversity-type circuits measures shall be taken to limit as far as possible the risk of defects occurring simultaneously in more than one circuit arising from a single cause.

5.9 Hydraulic system

5.9.1 The hydraulic system shall be designed so that the safety requirements for fluid power systems and components in EN 982 are met.

5.9.2 It shall be the responsibility of manufacturers to determine by calculations and test the working pressures which can occur in any part of the circuits.

5.9.3 Each hydraulic circuit shall be provided with a connection for a pressure gauge.

5.9.4 The design of the hydraulic system shall enable trapped air to be vented.

5.9.5 Any hydraulic tank open to atmosphere shall be equipped with an air breathing filter.

5.9.6 Each hydraulic tank shall be equipped with a device indicating the fluid level and marked with the maximum and the minimum level.

5.9.7 The hydraulic system shall be fitted with a pressure relief valve in order to provide protection against excess pressure. It shall be adjustable, sealed and designed so that the setting shall only be possible with the aid of special tools. The valve shall be adjusted for a pressure which is no more than 20 % above the pressure in operation with the rated load. If different maximum pressures are used in the hydraulic system then a corresponding number of pressure relief valves shall be provided.

5.9.8 Pressurised parts of the hydraulic system which may be subjected to the maximum pressure permitted by the pressure relief valve shall be designed to withstand at least twice that pressure without permanent deformation.

5.9.9 The bursting pressure of hoses, including fittings, which may be subjected to the maximum pressure permitted by the pressure relief valve shall be not less than four times that pressure.

5.9.10 All other parts of the hydraulic system shall be designed to withstand at least the maximum pressure to which they will be subjected.

5.9.11 Pilot operated control valves shall be so designed and installed that they fail to safety in the event of power failure.

5.10 Special requirements for safety devices, depending on auxiliary circuits and for overload/moment devices

5.10.1 The device shall be compatible with the designed use of the MCWP.

5.10.2 Devices shall be in accordance with EN 60204-1. Systems shall enable periodic functional checks to be carried out to verify that all functions are operating correctly.

5.10.3 If interruption of the power occurs, all data and calibration of the indicators shall be retained.

5.10.4 Limiting and indicating device systems shall fail to a "safe" condition, in which any fault results in a shutdown of the control circuits for normal operation.

5.11 Travel limit switches

5.11.1 Terminal stopping switches with contacts according to chapter 3 of EN 60947-5-1:1991 shall be provided and positioned so that they automatically stop the work platform from rated speed at the highest and lowest levels. At the lowest level, initiation of stopping should occur before contact with the buffer and before contact with the final limit switch. At the highest level, initiation of stopping shall occur before contact with the final limit switch.

5.11.2 An upper final limit switch shall be provided. It shall be positioned such that the work platform will come to a complete stop before reaching the top of the mast. After triggering the upper final limit switch, downward movement of the work platform may be permitted but no further upward movements shall be possible until corrective action has been taken by a competent person.

A lower final limit switch shall be provided. It shall interrupt the electric supply such that the work platform is not powered into the buffers. After triggering the lower final limit switch all movements of the work platform shall be prevented until corrective action has been taken by a competent person.

5.11.3 Separately mounted actuating and control devices shall be used for the terminal stopping (travel limit) switches and the final limit switches.

It is permitted to have one final limit switch to serve both the upper and lower limit switch functions.

5.12 Controls

5.12.1 On self-propelled MCWP it shall not be possible to operate the horizontal and vertical movement for the transfer controls simultaneously.

5.12.2 The control device for normal vertical movement shall be situated on the work platform only. The control device for horizontal movement of the MCWP-chassis shall not be situated on the platform.

5.12.3 If movement can be controlled from different control positions, the controls shall be interlocked in such a way that control is only possible from one pre-selected control position.

5.12.4 Platforms shall be provided with hand operated controls such that all movements of the platforms can only take place whilst the control is being actuated. When released, the controls shall automatically return to the neutral position. All controls shall be arranged to prevent inadvertent operation.

5.12.5 Whilst moving the platform vertically the positioning of the control station has to be arranged in a way to provide the operator with the best possible view of the travel area and to ensure safe movement of the platform. A warning sign shall be mounted on any movable station stating that vertical operation of the work platform from places other than the work platform itself is forbidden.

5.12.6 Emergency stop controls shall be arranged on the platform in accordance with EN 60204-1.

5.12.7 On starting, or restoration of the power after failure of the power supply, no further movement shall occur without the intervention of the operator.

5.12.8 Controls shall conform to EN 614-1 whilst taking into account the possibility of the operator wearing gloves.

6 Verification of the safety requirements and/or measures

6.1 Examinations and tests for each new model of MCWP

6.1.1 Design check

The design check shall verify that the MCWP is designed in accordance with this standard. It will include inter alia the check of the following documents:

a) Drawings containing the main dimensions of the MCWP;

b) Description of the MCWP with necessary information about its capabilities;

c) Information about the materials used;

d) Diagrams of the electrical, hydraulic and pneumatic circuits;

e) Operating instructions.

The above documents shall give all necessary information to enable

— The stability calculations to be checked (see 5.1.5)

— The structural calculations to be checked (see 5.1.4)

6.1.2 Practical tests

Practical tests shall be made to verify that

— The MCWP is stable;

— The MCWP is structurally sound;

— All functions work correctly and safely.

These tests shall be made:

a) In the case of a freestanding MCWP, with the mast erected to its maximum freestanding height;

b) In the case of a tied-in MCWP, with at least two ties in position at their maximum permitted spacings with maximum permitted top overhang.

MCWPs which are capable of operating in both freestanding and tied-in conditions shall be tested in both configurations.

6.1.2.1 Stability tests

6.1.2.1.1 The MCWP shall be set up on the maximum allowable inclination of the chassis defined by the manufacturer plus 0,5° with outriggers (if fitted) used as specified by the manufacturer. Test loads shall be applied to represent all the most unfavourable load and force combinations specified in 5.1.5.

The test may be carried out on level ground if the test loads are recalculated to include the effects of the maximum allowable inclination of the chassis defined by the manufacturer plus 0,5°.

The test loads may be applied at any suitable strong point, if necessary, to avoid overstressing any part of the MCWP.

The test is to be repeated in all the most unfavourable extended and/or retracted positions.

The untied MCWP is stable if it can come to a stationary condition without turning over while supporting the test load and force combination(s).

6.1.2.2 Braking test of the chassis

All MCWPs fitted with wheeled chassis shall be subjected to a brake test with the unloaded platform in the worst transfer condition. The brake must be able to stop and hold the MCWP in the worst transfer condition. Application of the brake must not induce instability.

6.1.2.3 Overload test

The test load shall be 125 % of the rated load. All movements with the test loads shall be carried out at accelerations and decelerations appropriate with safe control of the load.

When, due to the various combinations of loads or outreaches of a MCWP, tests with different test loads are necessary, all movements shall be carried out with all test loads except where the most unfavourable conditions can be sufficiently simulated by one performance test.

During the overload test the test load shall be put into each position which creates maximum stress in any load carrying part of the MCWP.

During the overload test the brakes shall be capable of stopping and sustaining the test load(s). After removing the test load(s) the MCWP shall show no permanent deformation.

The overload/moment device, if provided, shall be checked for compliance with 5.7.3 to 5.7.14.

6.1.2.4 Functional tests

6.1.2.4.1 General

Functional tests shall demonstrate that

— The MCWP can operate smoothly for all motions whilst carrying the rated load at the rated speeds;

— All safety devices work correctly;

— Maximum permitted speeds are not substantially exceeded.

6.1.2.4.2 Test of the systems to prevent the work platform from falling with overspeed according to 5.5.1.1. a) (safety gear)

Functional tests of the safety gear shall be carried out with the platform carrying 1,1 × the rated load. The work platform shall be allowed to overspeed to the governor tripping speed in order to determine that:

a) The overspeed device operates as specified by the designer, and

b) The safety gear is capable of arresting the motion of the work platform without the assistance of motor brakes and is within the designer's quoted stopping distance.

6.1.2.4.3 Test of the systems to prevent the work platform from falling with overspeed according to 5.5.1.1 b)

Functional tests of the independent drive units shall be carried out with the platform carrying 1,1 × the rated load. It shall be determined that:

a) The work platform can be stopped and sustained from rated speed by each of the drive units in turn by intentional release of the motorbrake of each one of the drive units in turn during the test;

b) The platform can be stopped and sustained from rated speed by intentional activation of the safety system according to 5.5.3 i);

c) In each case, the stopping distance is within the designer's quoted specification.

6.1.2.4.4 Test of the means for emergency lowering (and raising) of the work platform

a) For work platforms equipped with safety gear according to 5.5.1.1 a) check that the controls comply with 5.6.1 and 5.6.2 and that the work platform speed with 1,1 × rated load can be controlled according to the user instruction. Whilst lowering, permit the speed to increase further to the point where the safety gear operates, according to 5.6.3.

b) For work platforms equipped with means according to 5.5.1.1 b), check that the controls comply with 5.6.1 and 5.6.2 and that the lowering (and raising, if applicable) speed does not exceed 0,3 m/s with 1,1 × rated load on the work platform.

7 Information for use

7.1 Instruction handbook

7.1.1 Comprehensive information

Manufacturers or suppliers of MCWP shall supply in one of the official languages of the country where the MCWP is to be used, sufficient comprehensive information for the safe use of the MCWP. [A2] Presentation of this information shall comply with Clause 6 of EN ISO 12100-2:2003. [A2]

7.1.2 Content of the instruction handbook

The manufacturer and/or importer/supplier shall make available to the user an instruction handbook containing at the least, information about the following topics:

7.1.2.1 General information

— Manufacturer's or supplier's name and address;

— Country of manufacture;

— Model designation;

— Serial or fabrication number;

— Year of manufacture;

— Vertical travel speed (m/s);

— Horizontal transfer speed (m/s);

— Outdoor/indoor installation;

— Maximum allowable freestanding height in and out of service (m);

— Maximum allowable wind speed during erection and dismantling (m/s);

— Maximum allowable wind speed in and out of service (m/s);

— Hydraulic supply information if an external hydraulic power supply is used;

— Pneumatic supply information if an external pneumatic power supply is used;

— Electrical supply information if an external electric power supply is used;

— Warning sign required regarding moveable control stations.

7.1.2.2 Capacity information

The following information shall be made available, both for MCWP with non-varying work platform configuration and for MCWP with varying work platform configurations. In the case of variable configuration designs, the rated loads for particular main platform and platform extension configurations and any limitation as to load distribution shall be displayed each time the MCWP is installed (see 7.2.3).

— Maximum platform dimensions (length x width including platform extensions);

— Rated load (kg);

— Maximum lifting height, untied mast (m);

— Maximum lifting height, tied mast (m);

— Tie distance (m);

— Top overhang in operation (m);

— Maximum permitted force applied to tools (manually or mechanically assisted) which is to be reacted by the work platform;

— Maximum rated load on platform extensions (kg);

— Any load permitted on the work platform during transfer condition.

Sufficient information shall be given in the instruction handbook provided by the manufacturer such that the owner can derive the particular details for each configuration. These particular details shall then be augmented by the name of the erection site and a reference to the relevant chapter in the instruction handbook, such that the user can display this load diagram on the MCWP.

7.1.2.3 Dimensions and weights

— Height from the ground to the work platform in its lowest position for access (m);

— Platform section: length × width × height (m);

— Platform section: weight (kg);

— Mast section: length × width × height (m);

— Mast section: weight (kg);

— Drive unit: length × width × height (m);

— Drive unit: weight (kg);

— Chassis: length × width × height (m);

— Chassis: weight (kg);

— Outrigger spread and configuration: length × width (m);

— Base unit (specified transport configuration): weight and dimensions length × width × height (m);

— MCWP installed by crane: weight (kg);

— MCWP installed by crane: max height of mast (m);

— Minimum area required for installation: length × width (m).

7.1.2.4 Electrical data

— Power – lifting machinery (kW);

— Power – transfer machinery (kW);

— Supply voltage/frequency (V/Hz);

— Control voltage/frequency (V/Hz);

— Maximum starting current (A);

— Maximum power consumption (kVA);

— Minimum power supply (kVA);

— Main power supply fuses and type (A);

— Outlets for portable tools – voltage and current (V, A).

7.1.2.5 Safety equipment

— Type of safety equipment (e.g. safety gear, terminal stopping switches and final limit switches);

— Additional safety equipment for erection and dismantling;

— Emergency lowering equipment.

7.1.2.6 Additional technical information

This shall include the following:

— Outrigger arrangements;

— Ground bearing pressure and the hazards associated with changing ground conditions;

— Tie arrangement and forces imposed on the supporting structure, for given wind zones;

— Freestanding arrangements for given wind speeds;

— Need for protection regarding hazardous areas around the MCWP;

— Provision of adequate lighting for safe operation;

— Precautions about platform extension between the building and the mast;

— Information regarding any lifting points;

— Consideration of the possible requirements for lightning protection.

— Consideration of the effects of any item which significantly increases the wind area (see 5.1.2.3.3);

— Consideration of any effects which significantly increase the wind speed e.g. adjacent tall buildings etc.;

— Where any non-standard configurations are required, these shall be agreed between the manufacturer, the owner and the user, and information shall be added as an addendum to the instruction handbook;

— Transport procedure to and from site including the need for meeting the traffic regulations;

— Transfer of the MCWP around the site including maximum gradient;

— Instructions with regard to the use of slightly raised outriggers during transfer conditions in order to avoid instability from, for instance, failure of one tyre.

7.1.2.7 Operation instructions

These shall include the following:

— Operating procedures including information on safe distances such as the clearance to power cables and other overhead structures and between the platform and the building;

— Emergency procedures including the operation of safety devices, resetting by a competent person and action to be taken in case of power loss, including the safe use of the means for emergency lowering. This must include clear instructions regarding the safe lowering distance increments and any rest periods needed in order to avoid the overheating of brake linings;

— That travelling controls cannot be operated with any other movement unless the MCWP is in transfer condition;

— The use of relevant personal protective equipment such as hard hats, protective shoes, eye protection.

7.1.2.8 Operating personnel requirements

The instruction handbook shall state to the user the minimum requirements for the abilities of operating personnel.

7.1.2.9 Operating procedure requirements

These shall include the following:

— Each day before the MCWP is taken into use, the user shall check the operating devices, brakes and emergency stops. The condition of all trailing cables, travel limit switches, guardrails, structural connecting mast ties, cables and information plates shall also be checked;

— Keep the work platform clean from waste, building materials and of debris, snow etc.;

— Before any work is commenced, the operator shall visually check the outriggers and any timber or other packing on the ground shall be visually checked to ensure that it is in good order;

— Ensure that tools and other objects do not project outside the perimeter of the MCWP;

— During the work the operator shall carefully follow the operation instructions;

— At the end of the work period the platform shall be brought into the "out of service" position and it shall be isolated to prevent unauthorised operation;

— In the event of a fault with the MCWP, which can jeopardise safety, the operator shall immediately immobilise the MCWP and notify a responsible person;

— In case of emergency the operator must follow the relevant instruction in the user manual.

7.1.2.10 Maintenance instructions

These shall include the following:

— Schedule of regular maintenance together with required adjustments and tolerances and the required intervals and personnel skill requirements;

— Information on precautions to be taken against hazards during maintenance;

— Regular replacement of specific parts including discard criteria;

— Information on the replacement of safety critical parts by identical components;

— Information into how to seal adjustable components which have safety related functions;

— Troubleshooting information;

— Electrical/Hydraulic/Pneumatic schematic diagrams;

— Parts lists/diagrams;

— List of maintenance work to be carried out only by specially trained persons together with a definition of that training.

The manufacturer shall stress that regular maintenance shall include visual inspection and necessary functional test and maintenance measures. Special attention shall be given to the inspection of load-bearing parts with attachments, driving and stopping devices, operating and safety devices, racks and pinions etc.

7.1.2.11 Periodic examinations and test on MCWP

The instruction handbook shall state that the frequency and extent of periodic examinations and tests depends on national regulations, manufacturer's requirements, operating conditions and the frequency of use. It is normally not necessary to dismantle parts at periodic examinations, unless there are any doubts in relation to reliability and safety. The removal of covers, the exposure of observation apertures, and bringing the MCWP to the transport position are not considered to be dismantling.

The instruction handbook shall state the maximum time between periodic examinations and tests. Such examinations and tests shall at least consist of the following:

— A visual examination of the structure with special attention to corrosion and other damage of load bearing parts and welds

— An examination of the mechanical, hydraulic, pneumatic and electrical systems with special attention to safety devices.

7.1.2.12 Instructions for erection and dismantling

These shall include the following:

— Detailed explanation of erection and dismantling procedure with special attention to mast assembly, mast tie system, platform and extension assembly;

— Special hazards which can arise during erection and dismantling, with a description of any additional safety equipment and how this may be used to reduce these hazards. The use of personal protective equipment shall be mentioned in this connection;

— Preparation of the site with special regard to the bearing capacity of the foundation, gantry, asphalt etc.

— Preparation of the site so that under no circumstances can instability occur during transfer of the equipment when using movable chassis;

— If platform travel must be limited due to obstructions in the travel path and the platform therefore does not reach the normal limit switches, additional travel limit devices shall be installed to protect persons and material on the platform or the platform itself from hazardous situations;

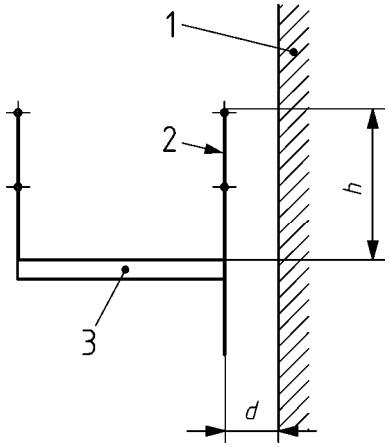
— Procedures to be observed when preparing the MCWP for transport shall be specified;

— If the MCWP can be loaded on a vehicle for transport or transfer suitable loading procedures must be given;

— The clear gap between the ends of adjacent MCWP shall be not less than 0,5 m;

— Precautions shall be taken to ensure the free and safe movement of any trailing cable throughout the full range of travel of the work platform. Where the mast is inclined or where multilevel work platforms to option B (annex B) are used, additional precautions are necessary, for example by making the cable follow the incline of the mast by the use of guides or the use of automatic cable reeling drums.

〈A1〉 Where the platform is erected towards a wall the instructions shall furthermore contain information regarding the required height (h) of guard rails on the work platform depending on the distance (d) between the platform and the wall according to Figure 9 and Table 8. The instructions shall include specific information to the user that it is very important to take into account the **local** use of the different guarding options in relation to the distance that is **locally** existing between platform and wall face. Users are responsible for any changes to, or removal of, guard rails in accordance with the legislation and possibly the working conditions in force in the member state where the platform is erected. 〈A1〉



Key

1 wall

2 guard rail

3 work platform

Figure 9

〈A1〉 Table 8 — Height of guard rails

d (m)	≤ 0,25	0,25 < d ≤ 0,4	> 0,4
h (m)	0,15 [c]	≥ 0,7 [b]	≥ 1,1 [a]
[a] with intermediate rail and toeboard according to 5.3.2.2 [b] without intermediate rail but with toeboard [c] height of toeboard			

Explanatory note to Table 8. The height "h" and the distance "d" has been chosen so as to avoid the risk of falling down between the platform and the wall, avoid ergonomic hazards and also to limit or reduce the crushing or shearing risk between the guard rail and wall obstacles when the platform is moving along the wall. 〈A1〉

7.1.2.13 Examinations and tests after major alteration or major repairs to a MCWP already in use

Examination and test after major alterations or major repairs to MCWPs already in use shall consist of the following

— Design check (see 6.1.1)

— Practical tests (see 6.1.2)

to an extent corresponding to the type of alteration of repair.

For the purpose of this European Standard "major alterations" are modifications of the whole or part of the MCWP, which affect stability, strength of performance.

7.1.2.14 Check list

A list shall be provided in the instruction handbook which contains all safety relevant parts of the MCWP to be checked after each erection. The result of the checks after each erection and the name and address of person(s) making it shall be recorded in a signed report.

7.2 Marking

7.2.1 General

The manufacturer shall provide the following information on one or more durable signs or plates mounted in a prominent place on the MCWP, in the official language of the country where the MCWP is to be used.

7.2.2 Information, non-varying

〈A2〉

— The business name and the full address of the manufacturer or his authorised representative; 〈A2〉

— Country of manufacture;

— Model designation;

— Serial or fabrication number;

〈A2〉

— the year of construction, that is the year in which the manufacturing process is completed; 〈A2〉

— Vertical travel speed (m/s);

— Transfer, travel speed (m/s);

— Out-/indoor installation;

— Maximum allowable freestanding height (m) in and out of service;

— Limiting windspeed during erection/dismantling;

— Maximum allowable windspeed in service/out of service [m/s];

— Hydraulic supply information if an external hydraulic power supply is used;

— Pneumatic supply information if an external pneumatic power supply is used.

— Electrical supply information if an external electric power supply is used;

— All guardrails to be in place at all times except for loading and unloading at the access level.

7.2.3 Information, varying

7.2.3.1 Capacity

A load diagram showing the rated loads for particular main platform and platform extension configurations and any limitation as to load distribution. This shall be derived from the information presented by the manufacturer according to 7.1.2.2.

The load diagram shall take the form of a durable sign or plate and shall be the responsibility of the user.

The manufacturer shall provide a means of mounting the load diagram.

7.2.3.2 Additional technical information

Outrigger arrangements and required ground bearing pressure.

Annex A
(informative)

Structural calculations

General

The calculations should conform to the rules and principles of applied mechanics and strength of materials. If special formulae are used, the sources should be given, if they are generally available. Otherwise the formulae should be developed from first principles, so that their validity can be checked.

A.1 In the absence of an EN-standard for design calculation the following guidelines may be used for the design of steel structures

A.1.1 Permissible stresses

Symbols	f_y	yield strength [N/mm^2]
	F_u	ultimate strength [N/mm^2]
	E = 210 000	modulus of elasticity [N/mm^2]
	G = E/(2×(1+v))	shear modulus [N/mm^2]
	v = 0,3	Poissons ratio
	δ_5	elongation at failure on gauge length of 5 times the diameter of the original cross section [%]
	S	Safety factor on yield strength

A.1.1.1 Non-alloy structural steels according to EN 10025

Table A.1 — Nominal values of material properties

Type	Yield 1) Strength f_y [N/mm^2]	Ultimate 2) Strength f_u [N/mm^2]
S235 (Fe360)	235	360
S275 (Fe430)	275	430
S355 (Fe510)	355	510
1) Standard value for smaller thickness 2) Minimum		

A.1.1.1.1 Permissible stresses for non-alloy structural steels

$\sigma_0 = f_y/S$

Table A.2 — Permissible stresses for non-alloy structural steels (N/mm^2)

Load case	A			B			C (N/mm^2)		
S	1,5			1,33			1,25		
Steel grade	235	275	355	235	275	355	235	275	355
Basic material and butt weld									
$\sigma_a = \sigma_0$	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 the case of larger thicknesses the corresponding value of fy should be taken into consideration.									

When selecting the materials special requirements should be taken into account, e.g.:

— Weldability;

— Use of the appliance in extreme climatic zones

A.1.1.2 Other steel grades

Depending on the minimum strength f_u and the elongation at failure δ_5 the following condition exists:

$510 < f_u \leq 590$ $\qquad \delta_5 \times f_u \geq 10800$

$510 < f_u$ $\qquad \delta_5 \times f_u \geq 9800$

If these conditions are fulfilled the following applies: fy' = 0,8 × fu.

If the conditions are not fulfilled, a reduced yield strength fy' should be defined with the factor r, which is applied to the ultimate strength f_u:

$$r = \frac{2600 - f_u\,(6+\delta_5)}{9600}$$

$1{,}28 \leq r \leq 1{,}44$

$$fy' = \frac{f_u}{r}$$

Values of "r" to be used should be not less than 1,28 and not more than 1,44.

Based on the lower value of the yield strength f_y or f_y' the permissible stresses should be calculated with the safety factors given for non-alloy structural steels.

A.1.1.3 Bolts

A.1.1.3.1 Black and fitted bolts

The permissible stresses are derived from X, which is the lower value of f_y and $0,7 \times f_u$.

$\sigma_a = X / S$ $\tau_a = \sigma_a / \sqrt{2}$

Table A.3 — Permissible stresses in bolts (N/mm^2)

		Grade	4.6	5.6	6.6	6.8	8.8	10.9
Load case	S	f_y	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	180	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

A.1.1.3.2 Preloaded bolts

Grade 8.8 and 10.9 only. Grade 12.9 may however be used if the conditions stated below are fulfilled. (See Eurocode 3 – ENV 1993-1-1:1992).

Symbols

A_s	tensile stress area of bolt [mm^2]
F_v	preload [N]
d	nominal bolt diameter [mm]
M_t	tightening torque [kNm]

Bolts used once $F_v = 0,8 \times f_y \times A_s$

Bolts used several times $F_v = 0,7 \times 0,8 \times f_y \times A_s$

Tightening torque $$M_t = \frac{0,18 \times d \times F_v}{1000}$$

The applied load F in relation to the preload F_v should be:

$F/Fv \leq 0,67$ for load case A

$F/Fv \leq 0,75$ for load case B

F/Fv ≤ 0,8 for load case C

A.1.1.3.3 Bearing pressure

The permissible bearing pressure σ_L depends on the basic material and is valid for bolted connections and also for pins.

Loose connection $\sigma_L = 1{,}3 \times \sigma_0$

Low accuracy, fixed connection $\sigma_L = 1{,}5 \times \sigma_0$

High accuracy, fixed connection $\sigma_L = 2{,}0 \times \sigma_0$

Table A.4 — Permissible bearing pressure (N/mm^2)

Load case	**A**			**B**			**C**		
Steel grade	235	275	355	235	275	355	235	275	355
Loose connection	204	238	308	229	268	346	244	286	369
Low accuracy, fixed connection	235	275	335	264	309	399	282	330	426
High accuracy, fixed connection	313	367	473	352	412	532	376	440	568

A.1.1.4 Combined stresses

Load carrying parts and butt welds:

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

Bolts, pin and fillet welds:

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

A.1.1.5 Elastic stability

A.1.1.5.1 Crippling

Symbols

λ	slenderness
λ'	specific slenderness
ω	crippling factor
F	compressive force [N]
A	area [cm^2]
M	bending moment [Ncm]
W_c	section modulus; compressive edge [cm^3]
W_t	section modulus; tensile edge [cm^3]
σ_a	permissible stress [N/cm^2]

The crippling factor is defined in the following way:

$$\lambda' = \frac{\lambda}{\pi} \times \sqrt{\frac{f_y}{E}}$$

For $0 < \lambda' \leq 1{,}195$ $\qquad \omega = \frac{1}{(1 - 0{,}195 \times \lambda' - 0{,}185 \times \lambda'^{2,5}}$

For $\lambda' > 1{,}195$ $\qquad \omega = 1{,}465\ \lambda'^{2}$

ω - factor already calculated for non-alloy structural steels see table A.5 to A.7.

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

The following conditions should be fulfilled:

$$\omega \times \frac{F}{A} + 0{,}9 \times \frac{M}{W_c} \leq \sigma_a$$

$$\omega \times \frac{F}{A} + \frac{300 + 2\lambda}{1000} \times \frac{M}{W_t} \leq \sigma_a$$

A.1.1.5.2 Buckling

Symbols

t	thickness of plate [cm]
b	width of plate [cm]
k	factor depending on the stress conditions
σ_e	Euler's buckling stress [N/mm^2]
σ_{ki}	ideal buckling stress [N/mm^2]
σ_{vki}	ideal combined buckling stress [N/mm^2]
σ_{vk}	reduced combined buckling stress [N/mm^2]
σ_1	higher stress [N/mm^2]
σ_2	lower stress [N/mm^2]

$\sigma_{ki} = k_\sigma \times \sigma_e$

$\tau_{ki} = k\tau \times \sigma_e$

$\psi = \sigma_1/\sigma_2$

The reduced buckling stress σ_{vk} is defined in the following way.

$\sigma_{vki} < 0,7 \times f_y$ $\quad\quad$ $\sigma_{vk} = \sigma_{vki}$

$\sigma_{vki} >= 0,7 \times f_y$ $\quad\quad$ $\sigma_{vk} = f_y \times \sqrt[4]{\frac{1-0,461}{(\sigma_{vki} / f_y)^{1,4}}}$

The required minimum safety factor v depends on the load combination.

Load case A $\quad\quad$ $v \geq 1,71 + 0,180 \times (\psi - 1,0)$

Load case B $\quad\quad$ $v \geq 1,50 + 0,125 \times (\psi - 1,0)$

Load case C $\quad\quad$ $v \geq 1,33 + 0,075 \times (\psi - 1,0)$

For further information refer to accepted buckling calculation methods.

A.1.2 Limit state method

The deflection of a structure should be taken into consideration when calculating the stresses. This is very important when calculating a slender design or using materials with a low modulus of elasticity and can be done by using the theory of the 2nd order. The safety factors against fy or fy' should be at least the following:

Load case A: $S \geq 1,50$

Load case B: $S \geq 1,33$

Load case C: $S \geq 1,25$

A.1.3 ω - values for non-alloy structural steels

Table A.5 — ω- values for S 235

	S 235 yield strength f_y = 235 N/mm^2									
λ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
20	1,05	1,05	1,05	1,06	1,06	1,06	1,07	1,07	1,07	1,08
30	1,08	1,08	1,09	1,09	1,10	1,10	1,10	1,11	1,11	1,11
40	1,12	1,12	1,12	1,13	1,14	1,14	1,14	1,15	1,16	1,16
50	1,17	1,17	1,18	1,18	1,19	1,19	1,20	1,21	1,21	1,22
60	1,23	1,23	1,24	1,25	1,26	1,26	1,27	1,28	1,29	1,30
70	1,31	1,31	1,32	1,33	1,34	1,35	1,36	1,37	1,39	1,40
80	1,41	1,42	1,43	1,45	1,46	1,47	1,49	1,50	1,52	1,53
90	1,55	1,56	1,58	1,60	1,61	1,63	1,65	1,67	1,69	1,71
100	1,74	1,76	1,78	1,81	1,83	1,86	1,89	1,92	1,95	1,98
110	2,01	2,05	2,08	2,12	2,16	2,20	2,24	2,27	2,31	2,35
120	2,39	2,43	2,47	2,51	2,55	2,60	2,64	2,68	2,72	2,76
130	2,81	2,85	2,89	2,94	2,98	3,03	3,07	3,12	3,16	3,21
140	3,26	3,30	3,35	3,40	3,44	3,49	3,54	3,59	3,64	3,69
150	3,74	3,79	3,84	3,89	3,94	3,99	4,04	4,09	4,15	4,20
160	4,25	4,31	4,36	4,41	4,47	4,52	4,58	4,63	4,69	4,74
170	4,80	4,86	4,91	4,97	5,03	5,09	5,15	5,20	5,26	5,32
180	5,38	5,44	5,50	5,56	5,62	5,69	5,75	5,81	5,87	5,93
190	6,00	6,06	6,12	6,19	6,25	6,32	6,38	6,45	6,51	6,58
200	6,64	6,71	6,78	6,85	6,91	6,98	7,05	7,12	7,19	7,26
210	7,33	7,40	7,47	7,54	7,61	7,68	7,75	7,82	7,89	7,97
220	8,04	8,11	8,19	8,26	8,33	8,41	8,48	8,56	8,63	8,71
230	8,79	8,86	8,94	9,02	9,10	9,17	9,25	9,33	9,41	9,49
240	9,57	9,65	9,73	9,81	9,89	9,97	10,05	10,13	10,22	10,30

Table A.6 — ω- values for S 275

	S 275 yield strength f_y = 275 N/mm^2									
λ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
20	1,05	1,06	1,06	1,06	1,07	1,07	1,07	1,08	1,08	1,08
30	1,09	1,09	1,10	1,10	1,10	1,11	1,11	1,12	1,12	1,13
40	1,13	1,14	1,14	1,15	1,16	1,16	1,16	1,17	1,18	1,18
50	1,19	1,20	1,20	1,21	1,22	1,22	1,23	1,24	1,25	1,25
60	1,26	1,27	1,28	1,29	1,30	1,31	1,32	1,33	1,34	1,35
70	1,36	1,37	1,38	1,40	1,41	1,42	1,44	1,45	1,46	1,48
80	1,49	1,51	1,53	1,54	1,56	1,58	1,60	1,62	1,64	1,66
90	1,68	1,70	1,73	1,75	1,78	1,80	1,83	1,86	1,89	1,92
100	1,95	1,99	2,02	2,06	2,10	2,14	2,18	2,23	2,27	2,31
110	2,35	2,39	2,44	2,48	2,53	2,57	2,62	2,66	2,71	2,75
120	2,80	2,85	2,89	2,94	2,99	3,04	3,09	3,14	3,18	3,23
130	3,29	3,34	3,39	3,44	3,49	3,54	3,60	3,65	3,70	3,76
140	3,81	3,86	3,92	3,97	4,03	4,09	4,14	4,20	4,26	4,32
150	4,37	4,43	4,49	4,55	4,61	4,67	4,73	4,79	4,85	4,91
160	4,98	5,04	5,10	5,16	5,23	5,29	5,36	5,42	5,49	5,55
170	5,62	5,68	5,75	5,82	5,89	5,95	6,02	6,09	6,16	6,23
180	6,30	6,37	6,44	6,51	6,58	6,65	6,72	6,80	6,87	6,94
190	7,02	7,09	7,17	7,24	7,32	7,39	7,47	7,55	7,62	7,70
200	7,78	7,85	7,93	8,01	8,09	8,17	8,25	8,33	8,41	8,49
210	8,57	8,65	8,74	8,82	8,90	8,99	9,07	9,15	9,24	9,32
220	9,41	9,49	9,58	9,67	9,75	9,84	9,93	10,02	10,10	10,19
230	10,28	10,37	10,46	10,55	10,64	10,73	10,83	10,92	11,01	11,10
240	11,20	11,29	11,38	11,48	11,57	11,67	11,76	11,86	11,96	12,05

Table A.7 — ω- values for S 355

	S 355 yield strength f_y = 355 N/mm^2									
λ	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
20	1,06	1,06	1,07	1,07	1,08	1,08	1,09	1,09	1,09	1,10
30	1,10	1,11	1,11	1,12	1,13	1,13	1,14	1,14	1,15	1,15
40	1,16	1,17	1,17	1,19	1,19	1,20	1,20	1,21	1,22	1,23
50	1,24	1,25	1,26	1,26	1,27	1,28	1,30	1,31	1,32	1,33
60	1,34	1,35	1,37	1,38	1,39	1,39	1,41	1,42	1,44	1,47
70	1,49	1,50	1,52	1,54	1,56	1,58	1,60	1,63	1,65	1,67
80	1,70	1,73	1,75	1,78	1,81	1,85	1,88	1,92	1,95	1,99
90	2,03	2,08	2,12	2,17	2,22	2,26	2,31	2,36	2,41	2,46
100	2,51	2,56	2,61	2,66	2,71	2,77	2,82	2,87	2,93	2,98
110	3,04	3,09	3,15	3,20	3,26	3,32	3,38	3,43	3,49	3,55
120	3,61	3,67	3,73	3,80	3,86	3,92	3,98	4,05	4,11	4,18
130	4,24	4,31	4,37	4,44	4,51	4,57	4,64	4,71	4,78	4,85
140	4,92	4,99	5,06	5,13	5,20	5,28	5,35	5,42	5,50	5,57
150	5,65	5,72	5,80	5,87	5,95	6,03	6,11	6,19	6,26	6,34
160	6,42	6,50	6,59	6,67	6,75	6,83	6,91	7,00	7,08	7,17
170	7,25	7,34	7,42	7,51	7,60	7,68	7,77	7,86	7,95	8,04
180	8,13	8,22	8,31	8,40	8,50	8,59	8,68	8,77	8,87	8,96
190	9,06	9,15	9,25	9,35	9,44	9,54	9,64	9,74	9,84	9,94
200	10,05	10,14	10,24	10,34	10,44	10,5	10,65	10,75	10,86	10,96
210	11,07	11,17	11,28	11,38	11,49	11,60	11,71	11,82	11,93	12,03
220	12,14	12,26	12,37	12,48	12,59	12,70	12,82	12,93	13,04	13,16
230	13,27	13,39	13,51	13,62	13,74	13,86	13,98	14,09	14,21	14,33
240	14,45	14,57	14,70	14,82	14,94	15,06	15,19	15,31	15,43	15,56

A.1.4 Analysis

A.1.4.1 General stress analysis

The general stress analysis is the proof against failure by yield or fracture. The analysis should be made for all load bearing components and joints.

A.1.4.2 Elastic stability analysis

The elastic stability analysis is the proof against failure by elastic instability (e.g. buckling, crippling). The analysis should be made for all load bearing components subjected to compressive loading.

A.1.4.3 Fatigue stress analysis

Only load case A has to be considered.

The fatigue stress analysis is the proof against failure by fatigue due to stress fluctuations. The analysis should be made for all load bearing components and joints which are critical to fatigue taking into account the constructional details, the degree of stress fluctuation and the number of stress cycles. The number of stress cycles may be a multiple of the number of load cycles.

The number of load cycles for a MCWP is normally

2×10^4 – intermittent duty (e.g. 10 years, 40 weeks per year, 25 hours per week, 2 cycles per hour).

It is permissible for the rated load to be multiplied by a load spectrum factor 0,5.

For further information refer to accepted fatigue stress analysis methods.

A.2 In the absence of an EN-standard for design calculations the following is applicable for the design of aluminium structures.

A.2.1 Permissible stresses

Symbols

f_y	yield strength [N/mm^2]
f_u	ultimate strength [N/mm^2]
E = 70 000	modulus of elasticity [N/mm^2]
G = 27 000	shear modulus [N/mm^2]
δ_5	elongation at failure on gauge length of 5 times the diameter of the original cross section [%]
S	safety factor on yield strength
V	safety factor on tensile strength

A.2.1.1 Standardised structural aluminium alloys

Table A.8 — Standardised aluminium alloys

Alloy No.	Alloy	Condition
1	AlZn4, 5Mg11	F35
2	AlMgSi1	F32
3	AlMgSi1	F28
4	AlMgSi0,5	F22
5	AlMg4,5Mn	G31
6	AlMg4,5Mn	W28
7	AlMg4,5Mn	F27
8	AlMg2Mn0,8	F20
9	AlMg2Mn0,8	F19
10	AlMg3	F18

A.2.1.1.1 Nominal values of material properties

Table A.9 — Properties of standardised aluminium alloys

Alloy No.	Nominal thickness t of the element t ≤ 10 mm	
	f_y [N/mm^2]	f_u [N/mm^2]
1	275	350
2	255	315
3	200	275
4	160	215
5	205	310
6	125	275
7	125	275
8	100	200
9	80	180
10	80	180

A.2.1.1.2 Permissible stresses

$\sigma_0 = f_y/S$ respectively f_u/V

$S_A \approx 1,7$; $V_A \approx 2,5$; $S_B \approx 1,55$; $V_B \approx 2,25$; $S_C \approx 1,4$; $V_C \approx 2,05$;

Table A.10 — Permissible stresses for standardised aluminium alloys in N/mm^2

	Load Case											
	A				B				C			
	Basic Material		Welds		Basic Material		Welds		Basic Material		Welds	
Alloy	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a
1	160	95	75	60	180	110	85	70	200	120	90	80
2	145	90	55	40	165	100	60	45	180	110	65	50
3	115	70	55	40	130	80	60	45	110	90	65	40
4	95	55	35	25	105	60	40	30	115	65	45	30
5	120	70	55	45	135	80	65	40	150	90	70	55
6	70	45	55	45	80	50	65	50	90	55	70	55
7	70	45	55	45	80	50	65	50	90	55	70	55
8	55	35	35	30	65	40	40	35	70	45	45	40
9	45	30	35	30	50	35	40	35	55	40	45	40
10	45	30	35	30	50	35	40	35	55	40	45	40

When selecting the materials, special requirements should be taken into account, e.g.:

— condition after heat treatment and ageing;

— weldability;

— use of the appliance in extreme climatic zones;

— for other material characteristics consult national standards.

A.2.1.2 Combined stresses

Load bearing parts and butt welds:

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

A.2.1.3 Elastic stability

Aluminium has a very low modulus of elasticity and a low shear modulus (~ 1/3 of the values of steel). Therefore the problems with the elastic stability are much more obvious compared with steel structures. Crippling, buckling, torsion buckling etc should be checked. Very slender constructions should be checked according to the theory of the second order.

A.2.1.3.1 Crippling, omega method

Symbols

λ slenderness

ω crippling factor

ω - factors already calculated for aluminium see table A.11 to A.14.

A.2.1.3.2 Limit state method

The deflection of a construction should be taken into consideration when calculating the stresses. This is very important when calculating a slender design or using materials with a low modulus of elasticity e.g. aluminium and can be done by using the theory of the 2nd order. The safety factors against f_y or f_y' should be at least the following:

Load case A S ≥ 1,7

Load case B S ≥ 1,55

Load case C S ≥ 1,4

A.2.2 ω - values for aluminium alloys

The figures are valid for profiles but may also be used for tubes.

Table A.11 — ω - values for aluminium alloys 1 and 2

	Alloy 1 yield strength f_y = 235 N/mm²					**Alloy 2 yield strength f_y = 260 N/mm²**				
λ	**0**	**2**	**4**	**6**	**8**	**0**	**2**	**4**	**6**	**8**
20	1,00	1,01	1,03	1,05	1,07	1,00	1,00	1,02	1,04	1,06
30	1,10	1,12	1,15	1,18	1,21	1,08	1,11	1,14	1,17	1,20
40	1,25	1,29	1,33	1,38	1,43	1,23	1,27	1,31	1,36	1,40
50	1,43	1,60	1,73	1,86	1,99	1,45	1,50	1,60	1,73	1,85
60	2,13	2,28	2,43	2,58	2,74	1,98	2,12	2,25	2,40	2,54
70	2,90	3,07	3,25	3,42	3,61	2,70	2,85	3,01	3,18	3,35
80	3,79	3,98	4,18	4,38	4,59	3,52	3,70	3,88	4,07	4,26
90	4,80	5,02	5,24	5,46	5,69	4,46	4,66	4,86	5,07	5,28
100	5,93	6,17	6,41	6,66	6,91	5,50	5,72	5,95	6,18	6,42
110	7,17	7,43	7,70	7,97	8,25	6,66	6,90	7,15	7,40	7,66
120	8,53	8,82	9,11	9,41	9,71	7,92	8,19	8,46	8,74	9,01
130	10,01	10,32	10,64	10,96	11,28	9,30	9,59	9,88	10,18	10,48
140	11,61	11,95	12,29	12,63	12,98	10,78	11,09	11,41	11,73	12,05
150	13,33	13,69	14,05	14,42	14,79	12,38	12,71	13,05	13,39	13,74
160	15,17	15,55	15,94	16,33	16,72	14,09	14,44	14,80	15,16	15,53
170	17,12	17,53	17,94	18,35	18,77	15,90	16,28	16,66	17,04	17,43
180	19,20	19,63	20,06	20,50	20,94	17,83	18,22	18,63	19,03	19,45
190	21,39	21,84	22,30	22,76	23,23	19,86	20,28	20,71	21,14	21,57
200	23,70	24,18	24,66	25,14	25,63	22,01	22,45	22,90	23,35	23,80

Table A.12 — ω - values for aluminium alloys 3, 4 and 5

	Alloy 3 and 5 yield strength f_y = 200 N/mm^2					Alloy 4 yield strength f_y = 160 N/mm^2				
λ	0	2	4	6	8	0	2	4	6	8
20	1,00	1,00	1,02	1,04	1,06	1,00	1,00	1,02	1,04	1,05
30	1,08	1,10	1,13	1,15	1,18	1,08	1,10	1,13	1,15	1,18
40	1,21	1,24	1,28	1,31	1,34	1,20	1,23	1,25	1,27	1,30
50	1,38	1,42	1,47	1,52	1,57	1,33	1,37	1,41	1,45	1,49
60	1,63	1,71	1,82	1,94	2,06	1,53	1,58	1,62	1,66	1,71
70	2,18	2,30	2,43	2,57	2,70	1,76	1,82	1,87	1,96	2,06
80	2,84	2,99	3,14	3,29	3,44	2,17	2,28	2,39	2,50	2,62
90	3,60	3,76	3,93	4,10	4,27	2,74	2,87	2,99	3,12	3,25
100	4,44	4,62	4,81	4,99	5,18	3,39	3,52	3,66	3,80	3,95
110	5,38	5,57	5,78	5,98	6,19	4,10	4,25	4,40	4,56	4,71
120	6,40	6,61	6,83	7,06	7,28	4,88	5,04	5,21	5,38	5,55
130	7,51	7,74	7,98	8,22	8,46	5,72	5,90	6,08	6,26	6,45
140	8,71	8,96	9,22	9,47	9,73	6,64	6,83	7,02	7,22	7,42
150	10,0	10,2	10,5	10,8	11,0	7,62	7,82	8,03	8,24	8,45
160	11,3	11,6	11,9	12,2	12,5	8,67	8,89	9,11	9,33	9,56
170	12,8	13,1	13,4	13,7	14,0	9,79	10,0	10,2	10,4	10,7
180	14,4	14,7	15,0	15,3	15,7	10,9	11,2	11,4	11,7	11,9
190	16,0	16,3	16,7	17,0	17,4	12,2	12,4	12,7	13,0	13,2
200	17,7	18,1	18,4	18,8	19,2	13,5	13,8	14,0	14,3	14,6

Table A.13 — ω - values for aluminium alloys 6 and 7

	Alloy 7 (profiles) yield strength f_y = 140 N/mm^2					Alloy 6 + 7 (profiles and box sections of sheet metal) yield strength f_y = 125 N/mm^2				
λ	0	2	4	6	8	0	2	4	6	8
20	1,00	1,00	1,01	1,03	1,05	1,00	1,00	1,01	1,03	1,05
30	1,07	1,09	1,11	1,14	1,16	1,07	1,09	1,11	1,14	1,16
40	1,19	1,21	1,24	1,27	1,30	1,19	1,21	1,24	1,26	1,29
50	1,33	1,35	1,38	1,42	1,45	1,32	1,35	1,38	1,41	1,44
60	1,49	1,53	1,57	1,61	1,65	1,47	1,51	1,55	1,58	1,62
70	1,70	1,75	1,80	1,85	1,90	1,66	1,70	1,75	1,79	1,84
80	1,96	2,01	2,09	2,19	2,29	1,88	1,93	1,98	2,03	2,08
90	2,40	2,51	2,62	2,73	2,85	2,14	2,24	2,34	2,44	2,55
100	2,96	3,08	3,20	3,33	3,46	2,65	2,75	2,87	2,98	3,09
110	3,59	3,72	3,85	3,99	4,13	3,21	3,32	3,44	3,57	3,69
120	4,27	4,41	4,56	4,70	4,85	3,82	3,94	4,07	4,21	4,34
130	5,01	5,18	5,32	5,48	5,64	4,48	4,62	4,76	4,90	5,05
140	5,81	5,97	6,14	6,32	6,49	5,19	5,34	5,50	5,65	5,82
150	6,67	6,85	7,03	7,21	7,40	5,96	6,12	6,28	6,45	6,62
160	7,58	7,78	7,97	8,16	8,36	6,78	6,95	,713	7,30	7,48
170	8,56	8,77	8,97	9,18	9,39	7,66	7,84	8,02	8,21	8,40
180	9,60	9,81	10,0	10,2	10,4	8,59	8,78	8,97	9,17	9,37
190	10,7	10,9	11,1	11,3	11,6	9,57	9,77	9,97	10,1	10,3
200	11,8	12,0	12,3	12,5	12,8	10,6	10,8	11,0	12,2	11,4

Table A.14 — ω - values for aluminium alloys 8, 9 and 10

	Alloy 8 yield strength f_y = 100 N/mm^2					Alloy 9 + 10 yield strength f_y = 80 N/mm^2				
λ	0	2	4	6	8	0	2	4	6	8
20	1,00	1,00	1,01	1,03	1,05	1,00	1,00	1,00	1,02	1,04
30	1,07	1,09	1,11	1,14	1,16	1,06	1,09	1,11	1,14	1,16
40	1,19	1,21	1,24	1,26	1,29	1,18	1,21	1,23	1,26	1,28
50	1,31	1,34	1,37	1,40	1,43	1,31	1,34	1,37	1,40	1,43
60	1,46	1,50	1,53	1,57	1,60	1,46	1,49	1,52	1,56	1,59
70	1,63	1,67	1,71	1,75	1,79	1,62	1,66	1,69	1,73	1,77
80	1,83	1,87	1,91	1,95	2,00	1,80	1,84	1,87	1,91	1,95
90	2,05	2,10	2,15	2,20	2,25	1,99	2,03	2,08	2,12	2,17
100	2,31	2,37	2,42	2,48	2,54	2,21	2,26	2,30	2,35	2,40
110	2,60	2,67	2,75	2,85	2,95	2,45	2,50	2,56	2,61	2,66
120	3,05	3,15	3,25	3,36	3,47	2,72	2,78	2,83	2,89	2,95
130	3,58	3,69	3,80	3,91	4,03	3,01	3,08	3,15	3,21	3,28
140	4,15	4,27	4,39	4,51	4,64	3,35	3,42	3,51	3,61	3,71
150	4,76	4,89	5,02	5,15	5,28	3,81	3,91	4,20	4,12	4,23
160	5,42	5,55	5,69	5,83	5,97	4,33	4,44	4,55	4,67	4,78
170	6,12	6,26	6,44	6,56	6,74	4,93	5,01	5,13	5,24	5,36
180	6,86	7,01	7,16	7,32	7,48	5,49	5,61	5,73	5,86	5,98
190	7,64	7,80	7,96	8,13	8,30	6,11	6,24	6,37	6,50	6,64
200	8,47	8,64	8,81	8,98	9,16	6,77	6,91	7,05	7,18	7,32

Annex B
(normative)

Special requirements for multilevel work platforms

Table B.1

OPTION A **Mounted on and/or below the primary Work Platform**		
Requirements	**Single Mast**	**Multiple Masts**
Allow for the effect on calculations / Rated load	Allow for mass of multilevel work platform	
Allow for additional forces on mast and mast ties	Yes	Yes
Allow for additional in & out of service wind forces	Yes	Yes
Allow for the effect on stability	Yes	Yes
Guard rails and toeboards	Yes	Yes
Ladder	Yes	Yes
Trap door	Yes	Yes
Fixings and stability of subsidiary work platform in relation to the primary work platform	YES, by adequate fixings to primary work platform	
Supported on primary work platform or on platform extensions or both	Yes, any combination	
Platform levelling	according to 5.3.1.1	according to 5.3.1.1 with assurance that clearance remains between subsidiary work platform and mast for full levelling range
Controls	Visibility must remain at control point	
Protection from falling objects	NA	
Emergency lowering	Standard arrangements	
Buffers	according to 5.3.4.10 and Instruction handbook	
Upper travel limit switch	Standard arrangements	
Lower travel limit switch	Special adjustment when subsidiary work platform is below primary work platform	
Separation distance between work platforms	Fixed separation < = 3 m	
Safety devices against falling (see 5.5)	Allow for any extra load	
Instruction handbook	Full information shall be given on how to erect and dismantle and the use of the multilevel platform	
NA = Not applicable		

Table B.2

OPTION B
Two or more Work Platforms
separately driven on common mast(s)

Requirements	Single Mast	Multiple Masts
Allow for the effect on calculations / Rated load	Independent calculation of each work platform	
Allow for additional forces on mast and mast ties	Yes	Yes
Allow for additional in & out of service wind forces	Yes	Yes
Allow for the effect on stability	Yes	Yes
Guard rails and toeboards	Yes	Yes
Ladder	No	See 5.3.4.7
Trap door	NA	NA
Fixings and stability of subsidiary work platform in relation to the primary work platform	NA	NA
Supported on primary work platform or on platform extensions	NA	NA
Platform levelling	Separate arrangements for each platform	
Controls	Separate controls for each platform	
Protection from falling objects	Lower work platform(s) must be protected from upper work platform – See 5.3.4.4 and Instruction Manual	
Emergency lowering	Standard arrangements	
Buffers	Standard buffers according to 5.4.4	
Upper travel limit switch	Separate switches for each platform	
Lower travel limit switch	Separate switches for each platform	
Separation distance between work platforms	See 5.3.4.6	
Safety devices against falling (see 5.5)	Separate arrangements each work platform	
Instruction handbook	Full information shall be given on how to create and dismantle and the use of the multilevel platform	
NA = Not applicable		

Annex C
(normative)

Requirements for electrical and electronic aspects of overload detecting devices

C.1 Reliability

C.1.1 Electronic components shall be selected on the basis of the most unfavourable load, temperature and tolerance parameters.

C.1.2 The power consumption of electronic components shall not exceed 66 % of the power stated by the manufacturer at an ambient temperature outside the housing of + 60 °C.

C.1.3 Detecting devices shall be such that their sound operation is not affected by ambient temperatures between – 20 °C and + 60 °C outside the housings. Within the range of these temperatures, deviation from the set value shall not exceed $\pm$ 3 %.

NOTE The design should take into account that under the circumstances described a higher temperature than + 60 °C can be reached inside the housing.

C.1.4 Electronic detecting devices or their components shall be such that their operation is not affected by:

a) Voltage pulses superimposed on the mains voltage:
Amplitude 1000 V
Pulse duration 50 µs (measured at 50 % of the peak value of the voltage pulse)
Rise time 0,2 to 0,5 µs

b) Voltage pulses between mains and earth:
Amplitude 500 V
Pulse duration 100 ns (measured at 50 % of the peak value of the voltage pulse)
Rise time 10 ns
Pulse repetition rate 10 Hz.

c) Voltage pulses between inputs or outputs and earth (common mode):
Amplitude 500 V
Pulse duration 100 ns (measured at 50 % of the peak value of the voltage pulse)
Pulse repetition rate 10 Hz
Rise time 10 ns.

d) Alternating magnetic fields:
Magnetic field strength 400 A/m
Frequency 50 Hz.

e) Electromagnetic fields:
Strength 4 V/m
Frequency 100 kHz to 500 MHz

C.2 Reporting defects

C.2.1 The occurrence in a detecting device of the defects given below in C.2.3 shall not cause inability to switch off the MCWP if the limit value is exceeded.

C.2.2 The detecting device shall be designed and connected to the electric installation of the MCWP in such a way that:

1) After the occurrence of one of the defects or actions given under C.2.3.1 a), the MCWP installation is automatically switched off and can no longer be started before the defect or interruption is eliminated and

2) After occurrence of one of the defects given under C.2.3.1 b) and after the MCWP is switched off, the MCWP can no longer be started before the defect is eliminated. This requirement does not apply if continued safe operation of the MCWP is automatically ensured by the detecting device.

NOTE The provisions under C.2.2 can be met by one of the following measures:

a) Design the circuit of the detecting device in such a way that the prescribed continued switched-off condition of the MCWP is achieved when a defect has developed;

b) Use a circuit to check the circuits in the detecting device for the presence of a defect. Such a circuit shall be designed and connected in such a way that:

— The relevant test key shall be operated after each MCWP shut-down before the MCWP installation can be started and

— The MCWP installation cannot be started if there is a defect in the test circuit or in the detecting device;

c) Design multiple circuits in the detecting device and incorporate them in a test circuit. The test circuit shall be designed and connected in such a way that the MCWP is switched off if there is a defect in the test circuit or one of the parallel circuits of the detecting device;

d) Earth or connect to the frame of a circuit in which relays or solenoid switches are incorporated to ensure the MCWP is switched off if earth or frame leakage occurs.

C.2.3 Defects to be anticipated

C.2.3.1 The following defects and actions shall be taken into account on the basis of C.2.1 and C.2.2:

a) Break, dislodging or detachment of a cable forming the connection between the individual units of the installation which are mounted in cabinets;

— Interruption or drop in (one of) the supply voltage(s) at any moment;

b) Earth or frame leakage or interruption in the circuit;

— A relay contact or a contactor failing to open or close;

— An auxiliary switch (such as a limit switch, hand operated switch, etc.) failing to open or close;

— Interruption or short-circuit in a signal transmitter (such as a potentiometer, strain gauge bridge or transducer);

— Interrupted connection of or short-circuit in a semiconductor component (such as transistor, diode or optocoupler) or a capacitator;

— Short-circuit or interruption in a resistor;

— A defect causing the output of an integrated circuit to give a positive or negative potential; if several similar circuits are mounted on a semiconductor printed circuit board, allowance shall be made for the same defect occurring simultaneously in all circuits.

NOTE Requirements for microprocessor applications are under consideration.

C.2.3.2 The provisions of C.2.3.1 do not apply to the following defects:

— Short-circuit between the cores of a cable if the cable satisfies the requirements provided in the relevant national standard(s) and if the rated voltage of the auxiliary circuit does not exceed that of the cable;

— A contact not opening if the relay satisfies the requirements in EN 60947-5-1 and proper protection against influences from the ambience is installed;

— A contactor contact not opening if the contact load does not exceed 25 % of its rated power and proper protection against influences from the ambience is installed;

— A control switch not opening which is forced open mechanically if the values specified by the manufacturer for electrical protection, rated power, method of installation, rate and angle of operation, etc, are taken into account for installation of the contact;

— Bridging of an auxiliary switch by (an) insulation defect(s) (but do apply if this results from earth leakage or moisture, against which a waterproof housing is often a reasonable solution);

— Interruption of or short-circuit between tracks of printed circuits if the printed circuits satisfy the applicable requirements specified in EN 60065.

— Short-circuit in an optocoupler if the creepage paths and air gaps between the connecting wires may be regarded as adequate and a test voltage of 2,8 kV can be sustained between the input and output circuits;

— Interruption or short-circuit in a resistor if the resistor has an insulating paint coating, a reduction of the rate power up to approximately 66 % has been applied and short-circuit of the resistor is otherwise also prevented (by, for example, its arrangement).

C.2.3.3 If more defects can occur in the detecting device due to a defect in a component, the provisions of C.2.1 and C.2.2 are then also applicable.

Annex ZA
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements, except ESR 1.5.8 and 1.7.4 f), of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

Annex ZB
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 2006/42/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements, except ESR 1.5.8 and 1.7.4.2 u) of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

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Headquarters 389
Chiswick High Road,
London, W4 4AL, UK
Tel +44 (0)20 8996 9001
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