

BS EN 1777:2010



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Hydraulic platforms (HPs) for fire fighting and rescue services — Safety requirements and testing

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National foreword

This British Standard is the UK implementation of EN 1777:2010. It supersedes BS EN 1777:2004+A1:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FSH/17/9, Fire appliances and associated operational equipment.

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

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English Version

**Hydraulic platforms (HPs) for fire fighting and rescue services -
Safety requirements and testing**

Bras Élévateur Aérien (BEA) des services d'incendie et de secours - Prescriptions de sécurité et essais

Hubrettungsfahrzeuge für Feuerwehren und Rettungsdienste, Hubarbeitsbühnen (HABn) - Sicherheitstechnische Anforderungen und Prüfung

This European Standard was approved by CEN on 6 February 2010.

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Foreword

This document (EN 1777:2010) has been prepared by Technical Committee CEN/TC 192 "Fire service equipment", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.

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

This document supersedes EN 1777:2004+A1:2009.

This document 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).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Significant changes

The significant changes with respect to the previous edition EN 1777:2004+A1:2009 are listed below:

- a) Scope revised to state more precisely, limitation of scope to HP's with classification group B – type 1 according to EN 280:2001, 1.4 only and deletion of requirements and tests relating to all other groups and types not covered by the scope, flat belts for extending structure drive systems excluded from scope;
- b) terms and definitions of "hydraulic platform (HP)" and "levelling" added;
- c) some terms and definitions revised;
- d) list of significant hazards editorially revised and hazards relating to self propelled HP's and Group A HP's (where the vertical projection of the centre of gravity of the load is always inside the tipping lines) deleted, which are outside the scope;
- e) specific tests directly linked to the appropriate requirement;
- f) requirements relating to temperature range, forces, calculation, fatigue stress analyses, chassis and stabilizers revised;
- g) requirements and tests added relating to "Moment sensing system with increased safety requirements and enhanced overload criteria" as a new, fourth solution to reduce tilting hazards and hazards caused by exceeding of permissible loads;
- h) requirements and tests added relating to a minimum residual load of 6 % of the vehicle's unladen mass (obtained on the not loaded side, in the most unfavourable position);
- i) new subclause 5.13 "Safety devices" added analogous to EN 280/A1:2004;
- j) requirement added that the extending structure shall be supported in the transport position in such a way as to avoid harmful vibrations during transport;
- k) requirement added that failures in wire rope or chain drive systems for extending structure shall be self-revealing;
- l) maximum tensile grade of the wires in wire rope drive systems for extending structure increased to 2 160 N/mm²;
- m) leadscrew and rack and pinion drive systems deleted;

- n) warning signals shall consist of a continuous visual warning and an acoustic signal;
- o) height difference after the static overload test is now depending from the rescue height (for HP's with a rescue height up to 30 m, the height difference shall be less than 100 mm following application of 150 % of the rated load 10 min after unloading, for HP's with a rescue height greater than 30 m the manufacturer shall state the maximum height difference);
- p) emergency evacuation means for the platform added (rescue ladder fixed in parallel to the extending structure or alternatives after carrying out a risk assessment);
- q) requirements on platform doors and guardrails/handrails revised;
- r) anchoring points for the allowed number of persons in the cage for personal protective equipment against falling added;
- s) device added to stop all aggravating movements on sustaining impact;
- t) requirements and tests relating to operator seat, controls and electrical systems revised;
- u) pneumatic and hydraulic control systems revised that besides the specific requirements the basic standards EN 983 and EN 982 applies;
- v) requirements and tests revised relating to static tilt angle δ ;
- w) at acceptance tests and at periodical examinations and tests the static overload test has been added;
- x) instruction handbook added with test report, where appropriate, detailing the static and dynamic tests;
- y) operating instructions for emergency added;
- z) marking revised;
- aa) Annex A and Annex B revised according to the changes in EN 280;
- bb) former Annex F (Calculation example — Dynamic factor, kerb test) deleted, because the kerb test relates to self propelled HP's, which are outside the scope;
- cc) content of standard editorially revised.

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, Croatia, 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 the United Kingdom.

Introduction

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

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this document.

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

As no satisfactory explanation could be found for the dynamic factors used for stability calculations in EN 280 and previous national standards, the results of the tests carried out by CEN/TC 98 "Lifting platforms" to determine a suitable factor and stability calculation method for mobile elevating work platforms (MEWPs) have been adopted. The test method is described in Annex B as a guide for manufacturers wishing to use higher or lower operating speeds and to take advantage of developments in control systems.

Similarly, to avoid the unexplained inconsistencies in wire rope coefficients of utilization and drum and pulley diameters found in other standards for lifting devices, EN 280:2001, Annex C based on DIN 15020-1, together with EN 280:2001, Annex D, have been adopted.

1 Scope

This European Standard applies to vehicle mounted Hydraulic Platforms (HP's) as defined in 3.1, intended for use by fire and rescue services. HP's may participate in fire fighting, rescue or protection of persons, protection of the environment and in a variety of other technical operations.

This document identifies the significant hazards (see Clause 4) for all sizes of HP's used by fire and rescue services, on the basis that they are supplied in a complete form, tested and ready for use. It also gives methods for the elimination or reduction of these hazards. This document applies only to HP's classified in group B – type 1 according to EN 280:2001, 1.4.

NOTE 1 HPs of group B – type 1 are those where the vertical projection of the centre of gravity of the load may be outside the tipping lines and for which travelling is only allowed with the HP in its travel condition.

Consequently this document does not apply to HP's with the following classification according to EN 280:2001, 1.4:

- group A – type 1;
- group A – type 2;
- group A – type 3;
- group B – type 2;
- group B – type 3.

This document is intended to be used in conjunction with EN 1846-2 and EN 1846-3.

This document deals with the technical safety requirements to minimise the hazards listed in Clause 4 which can arise during the commissioning, the operational use, the routine checking and maintenance of hydraulic platforms when carried out in accordance with the specifications given by the manufacturer or his authorised representative.

This document deals with all significant hazards, hazardous situations and events relevant to HP's, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer and taking account of their whole lifecycle (see Clause 4).

NOTE 2 The lifecycle includes construction, transport, assembly and installation, commissioning, use (including setting, teaching/programming or process changeover), operation, cleaning, fault finding, maintenance, decommissioning, dismantling and, as far as safety is concerned, disposal.

This document does not deal with the additional hazards for:

- use in underground work (mines);
- use in potentially explosive atmospheres;
- flat belts for extending structure drive systems.

This document is not applicable to HP's which were manufactured before the date of publication of this document by CEN.

2 Normative references

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

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

EN 842, *Safety of machinery — Visual danger signals — General requirements, design and testing*

EN 894-1, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators*

EN 894-2, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

prEN 894-4, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 4: Location and arrangement of displays and control actuators*

EN 981, *Safety of machinery — System of auditory and visual danger and information signals*

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

EN 983, *Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*

EN 1846-1:1998, *Firefighting and rescue service vehicles — Part 1: Nomenclature and designation*

EN 1846-2:2009, *Firefighting and rescue service vehicles — Part 2: Common requirements — Safety and performance*

EN 1846-3, *Firefighting and rescue service vehicles — Part 3: Permanently installed equipment — Safety and performance*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1:2003)*

CEN/TS 15989, *Firefighting vehicles and equipment — Symbols for operator controls and other displays*

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)*

EN ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1:2006)*

EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 13849-2, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation (ISO 13849-2:2003)*

EN ISO 13850, *Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)*

EN ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2001)*

EN ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders* (ISO 14122-4:2004)

ISO 2408:2004, *Steel wire ropes for general purposes — Minimum requirements*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

ISO 3864-2:2004, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

ISO 3864-3, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

ISO 4305, *Mobile cranes — Determination of stability*

ISO 4309, *Cranes — Wire ropes — Care, maintenance, installation, examination and discard*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1846-1:1998, EN 1846-2:2009, EN ISO 12100-1:2003 and the following apply.

NOTE The terms platform, extending structure, base, lowering/raising, slewing, rotating and travelling are illustrated in Figure 1 and Figure 2.

3.1

hydraulic platform

HP

<high rise aerial appliances for fire and rescue services> elevating platform consisting of a work platform and a hydraulic extending structure, mounted on a base that is a self propelled chassis and intended for moving persons and their equipment, and in some cases also fire fighting monitors, to working locations for interventions such as those related to fire fighting, rescue or protection of persons, protection of the environment and in a variety of other technical operations

3.2

platform

<high rise aerial appliances for fire and rescue services> fenced platform in which persons and equipment are carried and which can be moved under load to the required working position by the extending structure and/or by movement of the base

NOTE Secondary platforms may include for example extended floors outside guardrails for rescue purposes or landings for access to boom ladders.

3.3

extending structure

<high rise aerial appliances for fire and rescue services> one or more rigid or telescopic or articulating mechanisms, or any combination of them in the form of booms and/or ladders or scissor mechanism which may or may not slew on the base

3.4

stabilizer

<high rise aerial appliances for fire and rescue services> device or system used to maintain the stability of the HP

NOTE These include for example screw jacks, hydraulic jacks, outriggers, vehicle suspension locking devices, extending axles, systems for levelling the extending structure relative to the base, etc.

3.5
access position
<high rise aerial appliances for fire and rescue services> position of the HP to provide access to the platform

NOTE Access position and travel condition (see 3.6) may be identical.

3.6
travel condition
<high rise aerial appliances for fire and rescue services> condition of the HP prescribed by the manufacturer for travelling to and from the place of use

NOTE Access position (see 3.5) and travel condition may be identical.

3.7
lowering
operation to move the platform to a lower level

3.8
raising
operation to move the platform to a higher level

3.9
rotating
circular movement of the platform relative to the extending structure, around a vertical axis

3.10
slewing
circular movement of the extending structure around a vertical axis

3.11
travelling
<high rise aerial appliances for fire and rescue services> movement of the base

3.12
rated load
<high rise aerial appliances for fire and rescue services> maximum load at which a platform may be loaded vertically in the limits of the corresponding working envelope of the extending structure, composed of persons and loose equipment and except permanently fixed items which are not part of the rated load

NOTE There may be more than one combination of rated load and working envelope (see 3.13).

3.13
working envelope
<high rise aerial appliances for fire and rescue services> space, defined by the manufacturer, within which the platform, with rated load, can be operated

NOTE There may be more than one combination of rated load (see 3.12) and working envelope.

3.14
residual slope
<high rise aerial appliances for fire and rescue services> deviation from horizontal of the base or any slewing mechanism after deployment of the stabilizers

3.15
full flow hydraulic/pneumatic control
control where the control level or handle used by the operator is an integral part of, or is connected mechanically to, the valve which directs the full flow of the medium to the machine actuators (motors, cylinders, etc.) with no other intermediate control system (pilot hydraulic, master/slave, electrical, pneumatic, etc.)

NOTE There are hydraulic or pneumatic full flow controls.

3.16

operating time

<high rise aerial appliances for fire and rescue services> time required from the travel condition with the crew in the cab, to set any stabilizers to full width on a level supporting surface and, with one person on the platform, to reach the maximum rescue height, using the vehicle crew, and, if slewing exists, to reach the maximum rescue height at a position 90° to the longitudinal axis of the vehicle

NOTE See Figure 16.

3.17

rescue height

<high rise aerial appliances for fire and rescue services> vertical height from the horizontal ground surface to the bottom of the rescue cage without loading

NOTE The rescue height is expressed in metres (m).

3.18

rescue ladder rated load

<high rise aerial appliances for fire and rescue services> maximum number of persons each with a mass of 90 kg allowed on a ladder as specified by the manufacturer

3.19

access ladder

<high rise aerial appliances for fire and rescue services> ladder intended to access to the deck of the base and to the platform

3.20

rescue ladder

<high rise aerial appliances for fire and rescue services> ladder on or being part of the extending structure intended to be used for rescuing persons by carrying them down and for the crew by stepping down from the cage to the deck of the base

3.21

loose equipment

<high rise aerial appliances for fire and rescue services> item carried on the platform which is neither permanently secured nor part of the operator's basic minimum protective equipment

EXAMPLES Hoses, nozzles, rescue lines, resuscitators, etc.

3.22

manual force

<high rise aerial appliances for fire and rescue services> force exerted by operators on the platform on objects/structures which is outside of the platform when the platform is stationary

3.23

load sensing system

<high rise aerial appliances for fire and rescue services> system of monitoring the vertical load and vertical forces on the platform

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

3.24

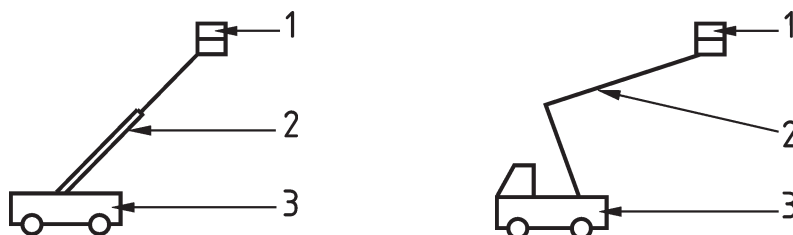
moment sensing system

<high rise aerial appliances for fire and rescue services> system of monitoring the overturning moment acting about the tipping line tending to overturn the hydraulic platform and system of monitoring exceeding permissible stresses

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

3.25 levelling

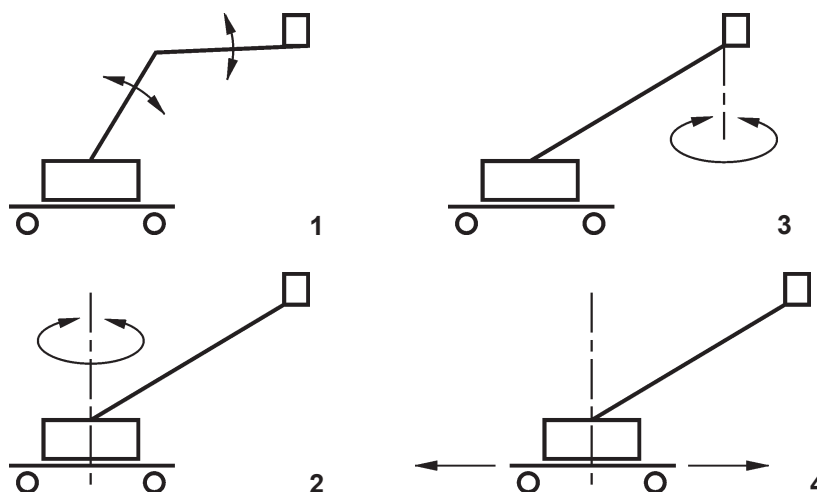
<high rise aerial appliances for fire and rescue services> device allowing the platform floor to be maintained at the horizontal position



Key

- 1 platform (3.2)
- 2 extending structure (3.3)
- 3 base

Figure 1 — Illustration of definitions in 3.2 and 3.3



Key

- 1 lowering/raising (3.7/3.8)
- 2 slewing (3.10)
- 3 rotating (3.9)
- 4 travelling (3.11)

Figure 2 — Illustration of definitions in 3.7 to 3.11

4 List of significant hazards

This clause contains in Table 1 all the significant hazards, hazardous situations and events, as far as they are dealt with in this document, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

The significant hazards are based on EN ISO 14121-1:2007, Annex A. Also shown are the subclause references to the safety requirements and/or protective measures in this document, if applicable.

Table 1 — List of significant hazards

No	Hazard	Corresponding clause/subclause in this document
4.1	Mechanical hazards:	
4.1.1	Crushing hazards	5.3.12, 5.4.4, 5.3.13, 5.6.7
4.1.2	Shearing hazards	5.3.12, 5.4.4
4.1.3	Cutting or Severing hazard	5.7.11
4.1.4	Entanglement hazard	5.3.14
4.1.5	Drawing-in or trapping hazard	5.3.14
4.1.6	Impact hazard	7.1.2, g) and 7.1.2, p)
4.1.7	Friction or abrasion hazard	7.1.7, e)
4.1.8	High pressure fluid injection hazard	5.7.15
4.1.9	Loss of stability (of machinery and machine parts)	5.2.4
4.1.10	Slip, trip and fall hazards	5.3.6, 5.3.18, 5.6.2, 5.6.3, 5.6.5, 5.6.6, 5.6.7
4.2	Electrical hazards, caused for example by:	
4.2.1	Electrical contact, direct or indirect	7.1.2, g)
4.2.2	Electrostatic phenomena	5.3.20
4.2.3	Thermal radiation	5.8
4.2.4	External influences on electrical equipment	5.8
4.3	Thermal hazards, resulting for example in:	
4.3.1	Burns and scalds by a possible contact of persons by flames or explosions and also by the radiation of heat sources	5.3.14
4.3.2	Health-damaging effects by hot or cold work environment	5.3.14
4.4	Hazards generated by noise, resulting for example in:	
4.4.1	Hearing losses (deafness) other physiological disorders e.g. loss of balance, loss of awareness, etc.)	5.3.10
4.4.2	Interference with speech communication, acoustic signals, etc	5.3.10
4.5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)	7.1.2, k)
4.6	Hazards generated by radiation, especially by:	
4.6.1	Machine making use of high frequency electromagnetic fields	5.8
4.7	Hazards generated by materials and substances processed, used or exhausted by machinery for example:	
4.7.1	Hazards resulting from contact with or inhalation of harmful fluids, gases, mists, dusts and fumes	5.3.16
4.7.2	Fire or explosion hazard	5.3.18
4.8	Hazards generated by neglecting ergonomic principles in machine design (mismatch of machinery with human characteristics and abilities) caused e.g. by:	
4.8.1	Unhealthy postures or excessive efforts	5.6.7
4.8.2	Inadequacy with human hand-arm or foot-leg anatomy	5.7.4, 5.7.5
4.8.3	Neglected use of personal protection equipment	5.7.4, 5.7.5
4.8.4	Inadequate local lighting	5.7.1
4.8.5	Mental overload or under-load, stress, etc.	5.4.6, 5.7.1, 5.7.6
4.8.6	Human errors	5.9.8, 5.10.11

Table 1 (continued)

No	Hazard	Corresponding clause/subclause in this document
4.9	Hazards caused by failure of energy supply, breaking down of machinery parts, and other functional disorders e.g.:	
4.9.1	Failure of energy supply (of power and/or control circuits)	5.7.8, 5.7.11, 5.7.14
4.9.2	Unexpected ejection of machine parts or fluids	5.7.15
4.9.3	Failure/disorder of control system	5.7.1, 7.2.2
4.9.4	Errors of fitting	5.8, 5.9.8, 5.10.11
4.9.5	Overturn, unexpected loss of machine stability	5.2.4, 6.1.2, 6.1.6
4.10	Hazards caused by (temporary) missing and/or incorrectly positioned safety-related measures/means, e.g.:	
4.10.1	All kinds of guard	5.3.14
4.10.2	All kinds of safety related (protection) devices	5.3.12, 5.4.4
4.10.3	Starting and stopping devices	5.7.1, 5.7.7
4.10.4	Safety signs and tags	5.10.10, 7.2.2, 7.3
4.10.5	All kinds of information or warning devices	5.3.1, 5.3.9, 7.1.7, c), 7.2
4.10.6	Energy supply disconnecting devices	5.10.10
4.10.7	Emergency devices	5.7.7, 5.7.11
4.10.8	Essential equipment and accessories for safe adjusting and/or maintaining	7.1.7, d)
4.10.9	Equipment evacuating gases, etc.	5.3.16
4.11	Inadequate lighting of moving/working area	5.7.1
4.12	Hazards due to sudden movement, instability, etc. during handling	5.2, 5.2.3
4.13	Inadequate/non ergonomic design of driving/operating position:	
4.13.1	Hazards due to dangerous environments (contact with moving parts, exhaust gases, etc.)	5.3.14, 5.3.16
4.13.2	Inadequate visibility from driver's/operator's position	5.3.13, 5.7.6
4.13.3	Inadequate seat/seating (seat index point)	5.4.6
4.13.4	Inadequate/non ergonomic design/positioning of controls	5.7.1
4.13.5	Starting/moving of self-propelled machinery	5.7.2
4.14	Mechanical hazards:	
4.14.1	Hazards to exposed persons due to uncontrolled movement	5.7.1
4.14.2	Hazards due to break-up and/or ejection of parts	5.2
4.14.3	Inadequate means of access	5.3.18, 5.6.7
4.14.4	Hazards due to batteries, fire, emissions, etc.	5.3.17, 5.3.19
4.15	Hazards due to lifting operation	
4.15.1	Lack of stability	5.4.1, 6.1.2
4.15.2	Loss of mechanical strength of machinery and lifting accessories	5.2.5, 5.4.1
4.15.3	Hazards caused by uncontrolled movements	5.4.1, 5.5.1.1, 5.5.1.3
4.16	Inadequate view of trajectories of the moving parts	5.7.6
4.17	Hazards caused by lightning	5.3.20
4.18	Hazards due to loading/overloading, etc.	5.4.1

Table 1 (continued)

No	Hazard	Corresponding clause/subclause in this document
4.19	General:	
4.19.1	Mechanical strength	5.5.2.2, 5.5.3.2
4.19.2	Loading control	5.4.1
4.19.3	Vibration damages of extending structure during transport	5.4.7
4.20	Controls:	
4.20.1	Controls in carrier	5.7.6
4.20.2	Safe speed control	5.7.2
4.21	Fall prevention:	
4.21.1	Personal Protective Equipment in carrier	5.6.3
4.21.2	Trapdoors	5.6.8
4.21.3	Carrier tilt control	5.6.1, 5.6.2
4.22	Carrier falling/overturning:	
4.22.1	Falling/overturning	5.5.1.1, 5.6.1, 5.6.2
4.22.2	Acceleration/braking	5.7.2
4.22.3	Markings	7.2
4.23	Insufficient means for evacuation/emergency exit	5.4.5

5 Safety requirements and/or protective measures

5.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100 (all parts) for relevant but not significant hazards, which are not dealt with by this document.

NOTE For hazards which are to be reduced by the application of a B-level standard such as EN ISO 13850, EN 982, EN 60204-1, the manufacturer should carry out a risk assessment to establish the requirements of the B-standard which are to be applied. This specific risk assessment should be part of the general risk assessment of the hydraulic platform.

Hydraulic platforms shall comply with the relevant clauses of EN 1846-2 and EN 1846-3.

Hydraulic platforms shall be designed and constructed taking account of the temperature range they are intended for.

5.2 Stability and structural calculations

5.2.1 General

Taking into account the relevant requirements of this document and the intended use of the machine, the manufacturer shall:

- for stability calculations, identify the various positions of the HP and combinations of loads, forces and removable items creating together conditions of minimum stability; and
- for structural calculations, evaluate the individual loads and forces in their positions, directions and combinations producing the most unfavourable stresses in the components.

NOTE It is the user's responsibility to refer other uses to the manufacturer for approval (see 7.1.2, a) and 7.1.8).

5.2.2 Loads and forces

The following loads and forces shall be taken into account:

- a) rated load;
- b) structural loads;
- c) wind loads;
- d) manual forces;
- e) additional loads and forces;
- f) those resulting from operation on any residual slope;
- g) those resulting from the use of the emergency stop in 5.7.7.

5.2.3 Determination of loads and forces

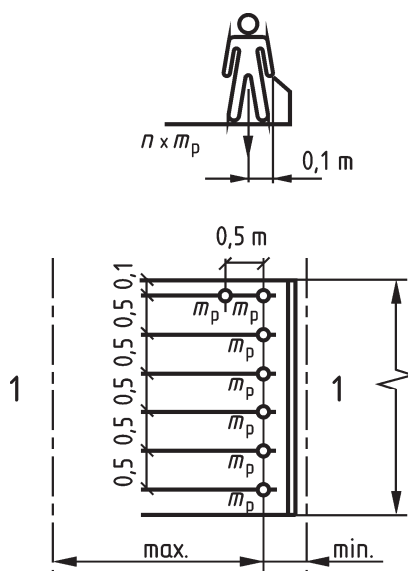
5.2.3.1 Rated load

The rated load is made up of persons, each with a nominal mass of 90 kg, and any loose equipment on the platform, within the limits of the corresponding working envelope. The mass of each person shall be taken to act as a point load on the platform at a horizontal distance of 0,1 m from the inside edge of the top rail with a distance between the point loads of 0,5 m. The mass of loose equipment shall be taken to act as an evenly distributed load on 25 % of the floor of the platform. All these loads shall be calculated in the positions and combinations giving the most severe results (see Figure 3 and Figure 4 as examples.).

The rated load shall be taken to act:

- a) statically when the platform is not moving;
- b) dynamically when the platform is moving.

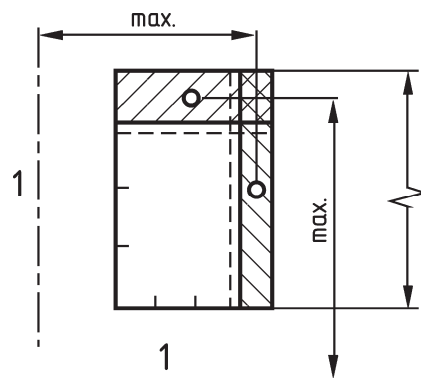
Dimensions in metres



Key

- 1 tipping line
- n number of persons
- m_p mass of each person

Figure 3 — Related load – persons



Key

1 tipping line

Figure 4 — Related load – equipment

5.2.3.2 Structural loads

The masses of the components of the HP and fixed items of equipment on the platform or the extending structure shall be taken to be static structural loads when they are not moving. These masses shall be taken to be dynamic structural loads when they are moving.

5.2.3.3 Rescue ladder rated load

The mass of each person on a ladder, on or forming part of the extending structure, shall be taken to act on one ladder rung. The maximum number of persons and their disposition on each ladder section shall be specified by the manufacturer.

5.2.3.4 Wind loads

5.2.3.4.1 HP's used out-of-doors shall be regarded as being affected by wind at a pressure of not less than 100 N/m^2 , equivalent to a wind speed of $12,5 \text{ m/s}$ (Beaufort Scale 6). See Annex A.

Wind forces are assumed to act horizontally at the centre of area of the parts of the HP and persons and equipment on the platform and/or ladders. They shall be taken to be dynamic forces.

If the HP is intended to be used at higher wind speed the corresponding higher forces shall be taken into account.

5.2.3.4.2 The following shape factors shall be applied to areas exposed to wind:

— L-, U-, T-, I-sections:	1,6
— Box sections:	1,4
— Large flat areas:	1,2
— Circular sections, according to size:	0,8/1,2
— Persons directly exposed:	1,0
— Shielded persons:	see 5.2.3.4.3.4

NOTE If additional information is needed, especially concerning shielded structural areas, see ISO 4302.

5.2.3.4.3 Area of persons on a platform or ladder exposed to wind

5.2.3.4.3.1 The full area of one person shall be taken as 0,7 m² (0,4 m average width × 1,75 m height) with the centre of area 1,0 m above the platform floor or ladder rung.

5.2.3.4.3.2 The exposed area of one person standing on a platform behind an imperforate section of fencing 1,1 m high shall be taken as 0,35 m², with the centre of area 1,45 m above the work platform floor.

5.2.3.4.3.3 The number of persons on a platform directly exposed to the wind shall be calculated as:

- a) the length of the side of the 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 platform if less than the number calculated in a).

5.2.3.4.3.4 If the number of persons allowed on the platform is greater than in 5.2.3.4.3.3, a) a shape factor of 0,6 shall be applied to the extra number of persons.

5.2.3.4.4 The maximum number of persons allowed on the ladders or the platform and their disposition on the ladders shall be as specified by the manufacturer.

5.2.3.5 Manual force

Unless the intended use includes higher manual forces, the minimum value for the manual force to be taken into account shall be at least 200 N for HP's designed to carry only one person and 400 N for HP's designed to carry more than one person, applied at a height of 1,1 m above the platform floor.

5.2.3.6 Additional loads and forces

When applicable, the rated load specified in 5.2.3.1 shall be modified to take into account the effect of:

- a) the mass of each person or equipment carried on secondary platforms taken to act as a point load at the centre of the floor area of the secondary platform;
- b) the mass of external loads (attached to the outside of the platform or the extended platforms), e.g. generator and similar equipment, are taken to act as a single point load at the attachment point.

5.2.3.7 Monitor reaction force

The reaction force for straight jets of water from smooth nozzles shall be calculated as:

$$R = \frac{2pa}{10} \quad (1)$$

where

- R is the reaction force in newtons (N);
- p is the pressure at the nozzle in bars;
- a is the nozzle area in square millimetres (mm²).

Figures for other types of nozzle (e.g. fog) or for fluid and semi-solid material (e.g. foam, dry powder) shall be taken from the manufacturer's specifications for the monitors or defined by testing.

5.2.4 Stability calculations

5.2.4.1 Calculation of forces and moments

5.2.4.1.1 Forces created by structural masses and rated loads

Forces acting vertically down that are created by structural masses and rated loads and which result in overturning or stabilizing moments shall be multiplied by a factor of 1,0 for the purpose of calculations. When these masses and loads are in motion they shall be multiplied by a factor of 0,1 to obtain the additional dynamic forces to be applied in the direction of movement creating the greatest overturning moment.

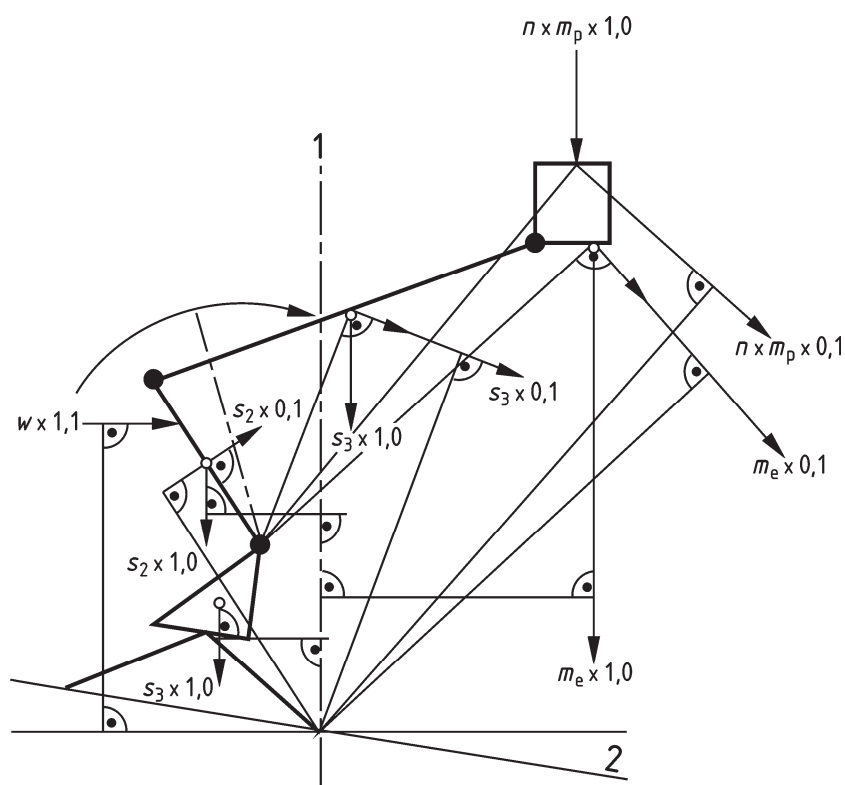
Manufacturers may use factors lower than 0,1 provided that their adequacy have been established by measurement of the effects of acceleration and deceleration in the most unfavourable situations.

5.2.4.1.2 Wind forces

Wind forces shall be multiplied by a factor of 1,1 and taken to be acting horizontally in the direction creating the greatest overturning moment.

5.2.4.1.3 Manual forces

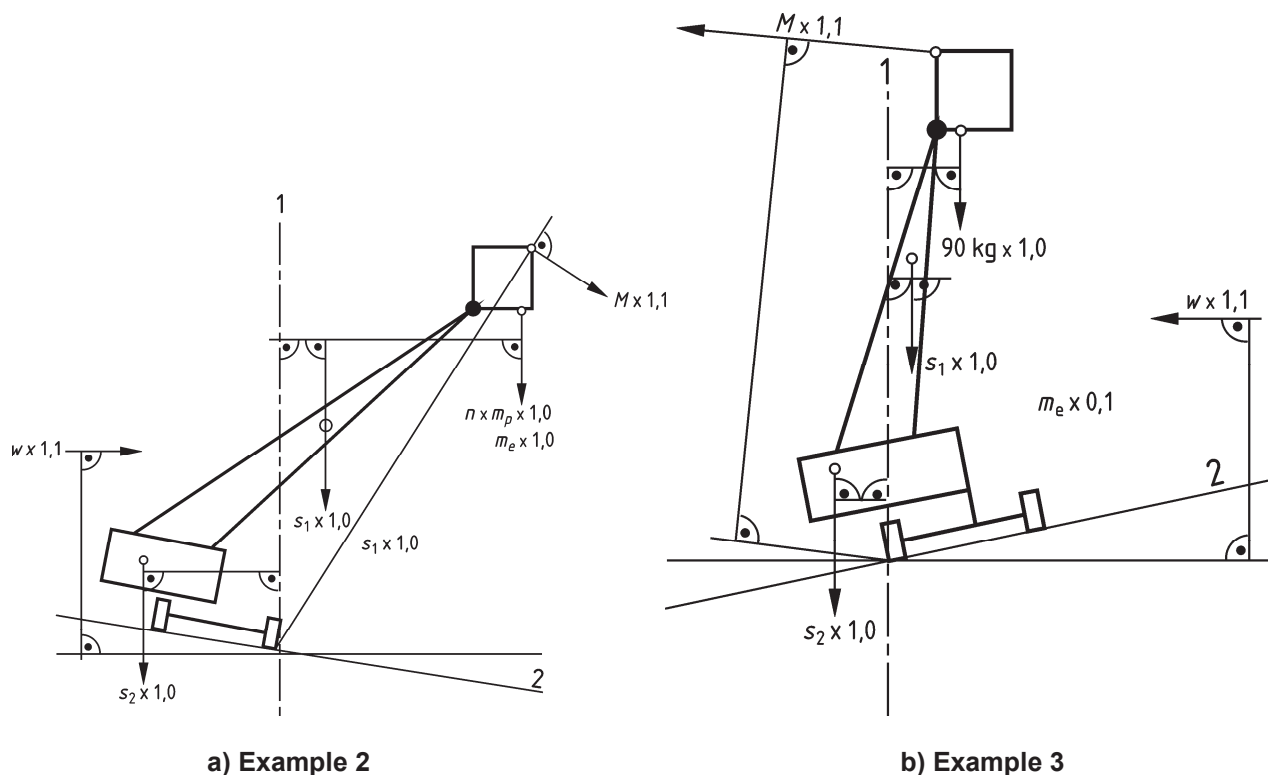
Manual forces applied by persons on the platform shall be multiplied by a factor of 1,1 and taken to be acting in the direction creating the greatest overturning moment (see Figure 5 to Figure 7 for examples).



Key

1	tipping line
2	max. slope + 0,5 °
n	number of persons
m_p	mass of each person
m_e	mass of loose equipment
$s_1, s_2, s_3,$	structural load
w	wind load

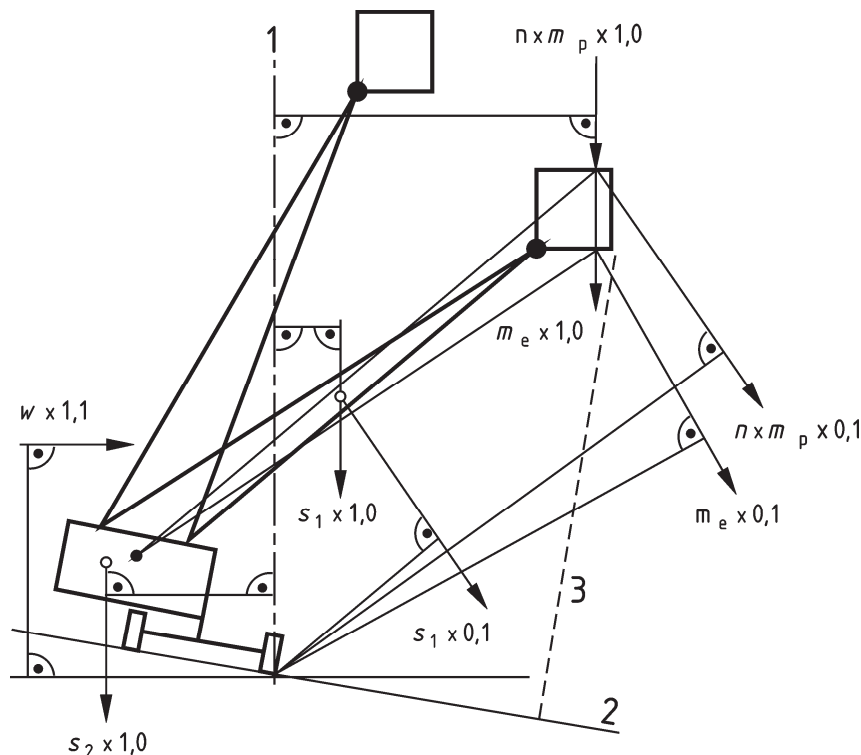
Figure 5 — Example 1 of maximum overturning load and force moment combinations (see Table 2)



Key

- 1 tipping line
- 2 max slope + 0,5 °
- n number of persons
- m_p mass of each person
- m_e mass of loose equipment
- s_1, s_2 structural load
- w wind load
- M manuel force

Figure 6 — Examples 2 and 3 of maximum overturning load and force moment combinations (see Table 2)



Key

1	tipping line
2	max slope
3	limited reach
n	number of persons
m_p	mass of each person
m_e	mass of loose equipment
s_1, s_2	structural load
w	wind load

Figure 7 — Example 4 of maximum overturning load and force moment combinations (see Table 2)

5.2.4.1.4 Additional loads and forces

Additional loads and forces according to 5.2.3.6 shall be treated in the same way as specified in 5.2.4.1.1, 5.2.4.1.2 and 5.2.4.1.3.

5.2.4.1.5 Calculation of overturning and stabilizing moments

The maximum overturning and corresponding stabilizing moments shall be calculated about the most unfavourable tipping lines, allowing for the failure of any one tyre in the case of HP's constructed for operation on pneumatic tyres.

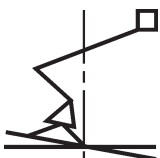
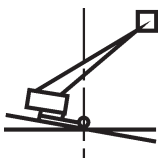
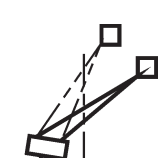
Tipping lines shall be determined as shown in ISO 4305 and Figure 5 to Figure 7 of this document.

For pneumatic tyres the tipping lines shall be taken at half the tyre width. For solid and foam filled tyres the tipping lines shall be taken at 1/4 of the tyre contact width from the outside of the contact width.

The calculations shall be made with the HP in the most unfavourable extended and/or retracted positions with the maximum allowable residual slope (see Figure 5 to Figure 7). An allowance of 0,5° inaccuracy in setting-up the HP shall be added to the maximum allowable residual slope defined by the manufacturer.

All loads and forces, which can act simultaneously shall be taken into account in their most unfavourable combinations. For example, when the load has a stabilizing effect an additional stability calculation shall be made assuming only one person (90 kg) is on the platform. Examples are shown in Table 2 and Figure 5 to Figure 7. Graphical methods may be used.

**Table 2 — Example of load and force directions and combinations for stability calculations
(see Figure 5 to Figure 7)**

Example	Operating condition and movement	Rated load (R)		Structural loads (Sn)		Manual force (M)		Wind loads (W)		Additional forces		Diagram
		× 1,0	× 0,1	× 1,0	× 0,1	× 1,0	× 0,1	× 1,0	× 0,1	× 1,0	× 0,1	
1	Raising (lowering)	V	A	V	A	-	-	H	H	a	a	
2	Forward stability, stationary on slope	V	-	V	-	A	A	H	H	a	a	
3	Backward stability, stationary on slope	90 kg V	-	V	-	A	A	H	H	a	a	
4	With limited reach, forwards stability, stationary on slope lowering	V	A	V	A	-	-	H	H	a	a	
Key V vertical H horizontal A angular a to be specified by the manufacturer												

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

Reference to Annex B will show that the safety margin is built into this method.

5.2.4.1.6 Influences on calculation

In the calculation the following influences shall be taken into account:

- distortions due to inaccuracies in the manufacture of the components;
- play in the connections of the extending structure;

- c) elastic deflections due to the effects of forces;
- d) performance of control devices (e.g. position/load/moment/movement controls);
- e) failure of any one tyre in the case of HP's supported by pneumatic tyres in the working position.

The determination of the play and elastic deflections shall be obtained by experiment or by calculation.

5.2.4.2 Verification of calculation of forces and moments

Verification: by examination that the calculations are correct and by the stability type tests in 6.1.2.

5.2.5 Structural calculations

5.2.5.1 General

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

For all load bearing components and joints the required information on stresses or safety factors shall be included in the calculations in a clear and easily verifiable form. If necessary for checking the calculations, details of the main dimensions, cross-sections and materials for the individual components and joints shall be given.

5.2.5.2 Calculation methods

Where no relevant harmonised European Standards are available the calculation methods shall comply with generally accepted standard(s) for lifting appliances and mobile cranes, which include fatigue stress calculation methods

Requirements laid down in 5.2.2 and 5.2.3 shall be considered for the determination of loads and forces to be used in the calculations.

The analysis defined in 5.2.5.3 shall be made for the worst load combinations and shall include the effects of a static overload test with $1,25 \times$ rated load or $1,5 \times$ rated load (see 6.1.4) and a dynamic overload test with $1,1 \times$ rated load (see 6.1.6.1.3).

The elastic deformations of slender components shall be taken into account.

The calculated stresses shall not exceed permissible values. The calculated safety factors shall not fall below the required values.

NOTE 1 Manufacturers are recommended, by strain-gauge tests or equivalent methods of analysis, to check peak stresses under the above dynamic test conditions (see also Annex B).

NOTE 2 The permissible values of stresses and the required values of safety factors depend on the material, the load combination and the calculation method.

For the design of hydraulic cylinders see 5.11.

5.2.5.3 Analysis

5.2.5.3.1 General stress analysis

The general stress analysis is the proof against failure by yielding or fracturing. The analysis shall be made for all load bearing components and joints.