

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

ICS 13.220.10

National foreword

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 It supersedes BS EN 1777:2004, which is withdrawn.

The start and finish of text introduced or altered by amendment in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted by Technical Committee FSH/17, Fire brigade equipment, to Subcommittee FSH/17/3, Fire appliances.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 18 November 2004

Amendments/corrigenda issued since publication

Date	Comments
31 May 2009	Implementation of CEN amendment A1:2009

ISBN 978 0 580 60406 5

© BSI 2009

English Version

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

Bras Élevateur 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 2 September 2004 and includes Amendment 1 approved by CEN on 11 January 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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.



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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword	3
Introduction	4
1 Scope.....	6
2 Normative references	7
3 Terms and definitions.....	7
4 List of significant hazards.....	10
5 Safety requirements and/or protective measures	14
6 Verification.....	38
7 Information for use	41
Annex A (informative) Special loads and forces — Use of HPs in wind speeds greater than Beaufort scale 6 (5.2.3.4.1)	65
Annex B (informative) Dynamic factors in stability and structural calculations	66
Annex C (informative) Major alterations and repairs	68
Annex D (normative) Design of wire rope drive systems for the extending structures and platform levelling systems	69
Annex E (informative) Calculation example of Annex D for wire rope, drum and pulley diameters	78
Annex F (informative) Calculation example — Dynamic factor, kerb test (see 5.2.4.1.1)	84
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC	86
Annex ZB (informative)  Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC 	87
Bibliography	88

Foreword

This document (EN 1777:2004+A1:2009) 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 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2009-01-11.

This document supersedes EN 1777:2004.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**.

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).

A1 For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. **A1**

This document includes a Bibliography.

It is one of a series of standards produced by CEN/TC 192 as part of the CEN/CENELEC programme of work to produce machine safety standards. It is based on the work of CEN/TC 98 EN 280 *Mobile Elevating Work Platforms (MEWPs)*, and allows for future adaptation of any type and size of MEWP to firefighting and rescue. Because of the wide variety of sizes and types of Hydraulic Platforms (HPs), it is not a detailed specification and performance specifications other than safety requirements are a matter for agreement between suppliers and customers. It is intended to be used in conjunction with Parts 1 and 2 of EN 1846.

It was accepted that the safety related parts of the control system would need to be reformulated to take account of the methodology of EN 954 but, in view of the further delays to publication this would cause, it was decided to defer this to a second stage.

Similarly, it was accepted that re-consideration of the need for load control on HPs with a single rated load should be deferred to a second stage, to avoid further delays to publication of the standard.

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 document has been prepared to be a harmonized standard to provide one means of conforming with the essential safety requirements of the Machinery Directive and its amending Directives, and associated EFTA Regulations.

It is a type C standard as stated in EN 1070.

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.

HPs are machines used primarily to provide Fire Services with a means of firefighting, rescuing persons from dangerous locations and access to other hazardous and/or working locations, by means of a platform on an extending structure mounted on a base.

Where the mass/rigidity of the base does not provide inherent stability, stability is assured by stabilizers interlocked with movements of the extending structure.

The movements of the extending structure are normally made by fluid power (hydraulics).

The platform is self-levelling and is primarily used to carry one or more persons and any necessary equipment and/or materials. It can be fitted with one or more monitors for projecting water or other fire-fighting fluids or semi-solid materials.

Controls are provided at the platform and at the base, to control movements of the extending structure. They can also control movements of the monitor(s) and of the base if it is mobile.

The extended positions of the platform can be above and/or below and horizontally beyond the surface supporting the base.

The extent to which hazards are covered is indicated in the scope of this document.

The safety requirements of this document have been drawn up on the basis that HPs are periodically maintained by persons trained according to manufacturer's instructions, working conditions, frequency of use, and national regulations.

It is also assumed that HPs are not put into operation unless all required control- and safety-devices are available and in working order and that persons operating HPs are adequately trained.

When mention is made of a design for the sake of clarity, this should not be considered to be the only possible design; any other solution may be applied if it is at least equally safe.

As no satisfactory explanation could be found for the dynamic factors used for stability calculations in previous national standards, the results of the tests carried out by 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, Annex C, of EN 280:2001, based on DIN 15020, together with Annex D of EN 280:2001, have been adopted.

1 Scope

1.1 General

This document identifies the significant hazards (see 4) in the use of all sizes of HP by fire fighting and rescue services, on the basis that they are supplied in a complete form, tested and ready for use, and gives methods for the elimination or reduction of these hazards and for the use of safe working practices.

NOTE The principles of this standard have been used for HPs ranging from the smallest up to working heights exceeding 70 m, and are expected to be applicable to all foreseeable developments of HPs for Fire Services.

This document deals with HPs, the base of which is normally a motor vehicle, but can also be static or fixed, or mobile in the form of:

- a trailer or de-mountable unit
- any other type of self-propelled vehicle

For vehicle mounted HPs this document is intended to be used in conjunction with EN 1846-2, *Fire fighting and rescue service vehicles —Part 2: Common requirements — Safety and performance*.

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

1.2 This document is applicable to the structural design calculations and stability criteria, constructional details and tests of HPs, and gives guidance on the intended life limits for HPs (see 5.2.5.2.2).

NOTE This document may also be used for machines similar to HPs equipped with monitors, surveillance or other equipment for firefighting use but not intended for lifting persons.

1.3 This document does not specify the special requirements for:

- HPs operated by programmable electronic systems and/or radio which do not rely on cables;
- use in underground work (mines);
- use in potentially explosive atmospheres;
- the use of pneumatic cylinders to operate load carrying components.

1.4 Classification

HPs are divided into two main types:

- Type A: HPs where the vertical projection of the centre of gravity of the load is always inside the tipping lines.
- Type B: HPs where the vertical projection of the centre of gravity of the load may be outside the tipping lines.

HPs are further divided into three groups related to travelling:

- Group 1: Travelling is only allowed with the HP in its transport position.
- Group 2: Travelling with raised platform is controlled only from a point of control at the chassis.

Group 3: (Self-propelled) Travelling with raised platform is controlled from a point of control at the platform.

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 418, *Safety of machinery — Emergency stop equipment, functional aspects — Principles for design*

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

EN 1846-2:2001, *Firefighting and rescue service vehicles — Part 2: Common requirements — Safety and performance*

EN 60204-1:1997, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:1997)*

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)*

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

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

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 and the following apply.

3.1 The abbreviation HP is used for Hydraulic Platform

3.2 platform

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.

Secondary platforms include extended floors outside guardrails for rescue purposes, landings for access to boom ladders, etc

3.3 extending structure

scissor mechanism or one or more rigid or telescopic or articulating mechanisms, or any combination of them in the form of booms and/or ladders. It may or may not slew on the base

3.4

stabilizers

all devices and systems used to maintain the stability of the HP. They include 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

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

condition prescribed by the manufacturer in which the HP is moved to and from the place of use

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

3.7

lowering

all operations to move the platform to a lower level

3.8

raising

all operations to move the platform to a higher level

3.9

rotating

any circular movement of the platform relative to the extending structure, about a vertical axis

3.10

slewing

any circular movement of the extending structure about a vertical axis

3.11

travelling

all movements of the base

3.12

self propelled HP

HP with travelling controls located at the platform

3.13

rated load

maximum load at which a platform may be loaded vertically in the limits of the corresponding working envelope of the extending structure. It is composed of persons and loose equipment. Permanently fixed items are not part of the rated load

NOTE There may be more than one combination of rated load and working envelope (see 3.14).

3.14

working envelope

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 3.13) and working envelope.

3.15

residual slope

deviation from horizontal of the base or any slewing mechanism after deployment of the stabilizers

3.16**full flow hydraulic/pneumatic controls**

controls 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 oil/air to the machine actuators (motors, cylinders, etc.) with no other intermediate control system (pilot hydraulic, master/slave, electrical, pneumatic, etc.)

3.17**pitching time**

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 at a position 90 ° to the longitudinal axis of the vehicle (if slewing exists), using the vehicle crew (see Figure 11)

3.18**rescue height**

vertical height, expressed in metres, from the horizontal ground surface to the base of the rescue cage without loading

3.19**ladder rated load**

maximum number of persons each with a mass of 90 kg allowed on a ladder as specified by the manufacturer

3.20**access ladder**

ladder not intended to be used for rescuing persons by carrying down

3.21**rescue ladder**

ladder intended to be used for rescuing persons by carrying down

3.22**loose equipment**

all items carried on the platform which are neither permanently secured nor part of the operator's basic minimum protective equipment, e.g. hoses, nozzles, rescue lines, resuscitators, etc

3.23**manual forces**

forces exerted by operators on the platform on objects/structures which are outside of the platform when the platform is stationary

3.24**load sensing system**

system for measuring the vertical load on the platform

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

3.25**moment sensing system**

system for measuring the overturning moment.

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

4 List of significant hazards

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

The significant hazards are based on EN 1050. (Also shown are the sub-clause references to the safety requirements and/or protective measures in this standard, if applicable).

Before using this standard it is important to carry out a risk assessment of the machine to check that its significant hazards are identified in this clause.

Hazard	Corresponding requirements	
4.1	Mechanical hazards:	
4.1.1	Crushing hazards	5.3.17, 5.4.4, 5.3.16, 5.3.18, 5.6.7
4.1.2	Shearing hazards	5.3.17, 5.4.4
4.1.3	Cutting or Severing hazard	5.7.11
4.1.4	Entanglement hazard	5.3.19
4.1.5	Drawing-in or trapping hazard	5.3.19
4.1.6	Impact hazard	7.1.2g and p
4.1.7	Stabbing or puncture hazard	NA
4.1.8	Friction or abrasion hazard	7.1.7.e)
4.1.9	High pressure fluid injection hazard	5.7.16
4.1.10	Ejection of parts	NA
4.1.11	Loss of stability (of machinery and machine parts)	5.2.4
4.1.12	Slip, trip and fall hazards	5.3.23, 5.6.3, 5.6.6, 5.6.7
4.2	Electrical hazards, caused for example by:	
4.2.1	Electrical contact, direct or indirect	7.1.2g)
4.2.2	Electrostatic phenomena	NA
4.2.3	Thermal radiation	5.8.1
4.2.4	External influences on electrical equipment	5.8.1
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	5.3.19
4.3.2	Health-damaging effects by hot or cold work environment	5.3.19
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)	7.1.2k
4.6	Hazards generated by radiation, especially by:	
4.6.1	Electrical arcs	NA
4.6.2	Lasers	NA
4.6.3	Ionising radiation sources	NA
4.6.4	Machine making use of high frequency electromagnetic fields	5.8.1
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	5.3.21
4.7.2	Fire or explosion hazard	5.3.22
4.7.3	Biological and micro-biological (viral or bacterial) hazards	NA

Hazard	Corresponding requirements	
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.	5.3.24, 5.7.1, 5.7.6
4.8.6	Human errors	5.9.8, 5.10.12
4.9	Hazard combinations	
4.10	Hazards caused by failure of energy supply, breaking down of machinery parts, and other functional disorders e.g.:	
4.10.1	Failure of energy supply(of power and/or control circuits)	5.7.9, 5.7.12, 5.7.15
4.10.2	Unexpected ejection of machine parts or fluids	5.7.16
4.10.3	Failure/disorder of control system	5.7.1, 7.2.2
4.10.4	Errors of fitting	5.8.3, 5.9.8, 5.10.12
4.10.5	Overturn, unexpected loss of machine stability	5.2.4, 6.1.2, 6.1.5
4.11	Hazards caused by (temporary) missing and/or incorrectly positioned safety-related measures/means, e.g.:	
4.11.1	All kinds of guard	5.3.19
4.11.2	All kinds of safety related(protection) devices	5.3.17, 5.4.4
4.11.3	Starting and stopping devices	5.7.1, 5.7.7
4.11.4	Safety signs and tags	5.10.11, 7.2.2
4.11.5	All kinds of information or warning devices	5.3.1, 5.3.9, 7.1.7c, 7.2
4.11.6	Energy supply disconnecting devices	5.10.11
4.11.7	Emergency devices	5.7.7, 5.7.12
4.11.8	Feeding/take-off means of work pieces	NA
4.11.9	Essential equipment and accessories for safe adjusting and/or maintaining	7.1.7 d
4.11.10	Equipment evacuating gases etc.	5.3.21
4.12	Inadequate lighting of moving/working area	5.7.1
4.13	Hazards due to sudden movement, instability etc. during handling	5.2, 5.2.3
4.14	Inadequate/non ergonomic design of driving/operating position:	
4.14.1	Hazards due to dangerous environments (contact with moving parts, exhaust gases etc)	5.3.19, 5.3.21
4.14.2	Inadequate visibility from driver's/operator's position	5.3.18, 5.7.6
4.14.3	Inadequate seat/seating (seat index point)	5.3.24
4.14.4	Inadequate/non ergonomic design/positioning of controls	5.7.1
4.14.5	Starting/moving of self-propelled machinery	5.3.16, 5.7.2
4.14.6	Road traffic or self-propelled machinery	5.3.12, 5.3.14

Hazard	Corresponding requirements	
4.15	Mechanical hazards:	
4.15.1	Hazards to exposed persons due to uncontrolled movement	5.7.1
4.15.2	Hazards due to break-up and/or ejection of parts	5.2
4.15.3	Hazards due to rolling over (ROPs)	NA
4.15.4	Hazards due to falling objects (FOPs)	NA
4.15.5	Inadequate means of access	5.3.23, 5.6.7
4.15.6	Hazards due to towing, coupling, connecting, transmission etc	NA
4.15.7	Hazards due to batteries, fire, emissions etc.	5.3.22, 5.3.25
4.16.1	Lack of stability	5.4.1, 6.1.2
4.16.2	Derailment of machinery	NA
4.16.3	Loss of mechanical strength of machinery and lifting accessories	5.2.5, 5.4.1
4.16.4	Hazards caused by uncontrolled movements	5.4.1, 5.5.1.1, 5.5.1.3
4.17	Inadequate view of trajectories of the moving parts	5.7.6
4.18	Hazards caused by lightning	 5.3.26 
4.19	Hazards due to loading/overloading etc.	5.4.1
4.20	General:	
4.20.1	Mechanical strength	5.5.2.1.2, 5.5.3.1.2
4.20.2	Loading control	5.4.1
4.21	Controls:	
4.21.1	Controls in carrier	5.7.6
4.21.2	Safe travel control	5.23.13, 5.7.6
4.21.3	Safe speed control	5.3.13, 5.7.2
4.22	Fall prevention:	
4.22.1	Personal Protective Equipment in carrier	NA
4.22.2	Trapdoors	5.6.8
4.22.3	Carrier tilt control	5.6.1, 5.6.2
4.23	Carrier falling/overturning:	
4.23.1	Falling/overturning	5.5.1.1, 5.6.1, 5.6.2
4.23.2	Acceleration/braking	5.7.2
4.23.3	Markings	7.2
NOTE	N/A = not applicable	

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 12100-2 for hazards relevant but not significant, which are not dealt with by this document (e.g. sharp edges.)

Vehicle mounted HPs shall comply with EN 1846-2, *Fire fighting and rescue service vehicles — Part 2: Common requirements — Safety and performance*

This clause of the document contains several requirements for the design of the safety related parts of the control system of HPs. As the terminology is not in accordance with that of the relevant harmonised standard, EN 954-1 (see Foreword) these requirements should be interpreted on the basis of the principles of EN 954-1 pending the planned revision of this document.

5.2 Stability and structural calculations

5.2.1 General

It is the manufacturer's responsibility

- for stability calculations, to 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, to 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.

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 created by use of the emergency stop 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 Figures 2 and 3 as examples.)

The rated load shall be taken to act

- statically when the platform is not moving;
- dynamically when the platform is moving.

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 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 round. 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 HPs used out-of-doors shall be regarded as being affected by wind at a pressure of not less than 100 N/m², equivalent to a wind speed of 12,5 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 users require use in higher wind speeds, the higher forces shall be taken into account by the manufacturer.

5.2.3.4.2 Shape factors 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

If additional information is needed, especially concerning shielded structural areas, see ISO 4302. For shielded persons, see 5.2.3.4.3.4.

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 round.

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 5.2.3.4.3.3a) 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

The value for the manual force shall be taken to be 200 N acting at a height of 1,1 m above the platform floor. Any greater force permitted shall be stated by the manufacturer.

5.2.3.6 Additional loads and forces

When applicable, the rated load specified in Clause 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, e.g. pumps and similar equipment, taken to act as a single point load at the attachment point. The attachment point shall be rated to carry the full rated load of the platform.

5.2.3.7 Monitor reaction force

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

$$R = \frac{2pa}{10}$$

where

R is the reaction force in Newtons

p is the pressure at the nozzle in bars

a is the nozzle area in mm²

Figures for other types of nozzle (e.g. fog), fluid and semi-solid material (e.g. foam, dry powder) are to be provided by the manufacturers in writing or proved by test.

5.2.4 Stability calculations

5.2.4.1 Calculation of forces

5.2.4.1.1 Forces created by structural masses and rated loads causing overturning or stabilizing moments shall be multiplied by a factor of 1,0, calculated as acting vertically downwards. When moving, they shall also be multiplied by a factor of 0,1, calculated as acting in the direction of movement creating the greatest overturning moment.

Manufacturers may use factors lower than 0,1, provided they have been proved by test (see Annex B).

For the travelling movements of HPs of Groups 2 and 3 the factor of 0,1 is replaced by a factor 'Z' representing the forces produced by acceleration and deceleration including the test 6.1.5.2. This factor shall be determined by calculation or test. See Annex F for a calculation example.

5.2.4.1.2 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 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 Figures 4 to 7 for examples).

5.2.4.1.4 Additional loads and forces according to 5.2.3.6 shall be treated in the same way as specified in 5.2.4.1.1/2/3.

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 HPs constructed for operation on pneumatic tyres.

Tipping lines shall be determined as shown in ISO 4305 and Figures 4 to 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. 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 1 and Figures 4 to 7. Graphical methods may be used.

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 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;
- elastic deflections due to the effects of forces;
- performance of control devices (e.g. position/load/moment/movement controls).

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

5.2.4.2 Verification of 5.2.4: by calculations in the technical file and the stability type tests in 6.1.2, 6.1.5.2 and 6.1.5.3.

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

5.2.5.2.1 The methods of calculation shall comply with any one of the recognised national design standards such as those of the EEA countries for lifting appliances and mobile cranes, which include fatigue stress calculation methods.

Requirements laid down in Clauses 5.2.2 and 5.2.3 shall be considered for the determination of loads and forces to be used in the calculations. The use of a national standard shall not reduce these requirements.

The analysis defined in 5.2.5.2.2 shall be made for the worst load combinations and shall include the effects of a static test with $1,25 \times$ rated load or $1,5 \times$ rated load (see 6.1.3) and a dynamic test with $1,1 \times$ rated load (see 6.1.5.1.3).

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

NOTE 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).

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.

5.2.5.2.2 Analysis

a) The 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.

b) Elastic stability analysis

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

c) Fatigue stress analysis

The fatigue stress analysis is the proof against failure due to stress fluctuations. When determining the load combinations for fatigue stress analysis it is permissible for the rated load to be reduced by the load spectrum factor according to Figure 8, and wind loads and other intermittent loads need not be taken into account. The analysis shall 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 for components may be a multiple of the number of load cycles.

For the purpose of this standard a load cycle starts when the platform is loaded in the access position and finishes when the platform is unloaded in the access position after being extended to a working position. For calculation purposes the number of load cycles for HPs in fire service use shall be taken as:

— 58,000 - (15 years, 52 weeks per year, 15 hours per week, 5 cycles per hour).

NOTE For the design of wire rope drive systems see Annex D.

5.2.5.2.3 Ladders on or forming part of the extending structure

Each round shall be designed to support a test load of 180 kg - access ladders, or 300 kg - rescue ladders, applied vertically downwards at any possible attitude of the ladder, on the central 100 mm width of the round, without permanent distortion (Rp 0,2). The supports of any ladders attached to the extending structure shall be designed to support a 180 kg test weight for each of the maximum number of persons allowed on each ladder section and at the dispositions specified by the manufacturer, without permanent distortion (Rp 0,2).

Side rails shall be designed to support a side force of 200 N for each person allowed on the ladder by the manufacturer at 2 m spacing along their length without permanent distortion (Rp 0,2).

5.2.5.3 Verification of 5.2.5: by design calculations in the technical file, the static overload type test 6.1.3 and ladder type tests 6.1.4.

5.3 Chassis and stabilizers

5.3.1 Every HP shall have a device, e.g. a spirit level, to indicate whether the residual slope after operation of any stabilizers is within the limits permitted by the manufacturer. This device shall be protected against damage and unintended change of setting.

For HPs with power driven stabilizers the indication shall be clearly visible from each appropriate control position.

On Group 3 HPs reaching the limits of inclination of the supporting surface this shall be indicated by an acoustic signal audible at the platform.

Verification: by visual examination and functional test.

5.3.2 HPs which are constructed for operation with stabilizers shall be equipped with devices which prevent operation of the extending structure, except as permitted by 5.3.4, unless all the stabilizers are correctly activated.

Verification: by design check and functional test.

5.3.3 Any permitted movement of the extending structure before the stabilizers are activated shall not create an unstable condition.

Verification: by functional test.

5.3.4 For Group 1 HPs, it shall only be possible to operate any stabilizers if the extending structure is in the travel condition. Group 2 and 3 HPs with stabilizers shall be fitted with a device to prevent any activation of the stabilizers if the platform is in a position where stabilizers are needed.

Verification: by design check and functional test.

5.3.5 Mechanical means shall be provided to prevent uncontrolled movements of the stabilizers from the transport position. The stabilizers shall be locked in the transport position by two separate locking devices for each stabilizer, at least one of which operates automatically, e.g. a gravity locking pin plus a detent.

Powered stabilizers meeting the requirements of 5.11 meet this requirement

Verification: by design check and functional test.

5.3.6 For HPs with stabilizers for levelling the extending structure these shall be capable of levelling it within the maximum residual slope when operating on the maximum slope specified by the manufacturer.

Verification: by functional test.

NOTE The normally accepted supporting surface variations within which HPs for general fire service use may be operated without restriction are:

- longitudinal and transverse slopes, up to 7 °;
- depressions, up to 50 mm;
- humps (kerbs, etc.), up to 150 mm.

5.3.7 The movements of stabilizers shall be limited by mechanical stops. These stops shall be of sufficient strength to absorb the maximum force exerted. The ends of hydraulic cylinders, if properly constructed for the purpose, fulfil this requirement.

Verification: by design check.

5.3.8 Any stabilizer feet shall be constructed to accommodate ground unevenness of at least 15 ° in any direction.

Verification: by visual examination and measurement.

5.3.9 Vehicle mounted HPs shall be equipped with an indicator visible to the driver to indicate if the HP is not in its transport condition.

Verification: by functional test.

5.3.10 Vehicle mounted HPs shall comply with all of the noise reduction requirements of EN 1846-2.

5.3.11 HPs which are operated in public traffic areas shall satisfy the national road traffic and lighting regulations.

Verification: by visual examination.

5.3.12 Group 3 HPs shall be equipped with brakes or other stopping devices which engage automatically when power is removed or fails, and remain effective if any one wheel lifts clear of the supporting surface due to operation of the extending structure or travelling. After being engaged, the brakes shall not depend on an exhaustible energy source.

Verification: by design check.

5.3.13 It shall not be possible to exceed the following travel speeds with manned platforms out of the transport position on HPs of Groups 2 and 3.

- a) Vehicle mounted HP, 1,5 m/s (Group 2).
- b) Rail mounted HP, 3,0 m/s (Group 3).
- c) Self-propelled HP, 0,7 m/s (Group 3).

Verification: by functional test.

5.3.14 HPs travelling at the maximum speeds 5.3.13. a), b), c) on the maximum slope allowed by the manufacturer shall be capable of being stopped in distances not greater than given in Figure 12.

Verification: by functional test.

5.3.15 An automatic safety device shall be fitted to prevent the travel of Group 1 HPs when the platform is out of the travel condition, e.g. by interlocking the two drive controls. Any travel speed restriction for Group 3 HPs, when the platform is out of the travel condition shall be automatic, e.g. by the use of hydraulic diverter valves or smaller hydraulic pumps.

Verification: by design check and functional test.

5.3.16 The position of any travel controls shall be at a safe distance from any wheels or tracks.

Verification: by visual examination.

5.3.17 Trapping and shearing points between parts of the stabilizers and the base or ground shall be avoided by providing safe clearances in accordance with EN 349 or adequate guarding. For areas such as stabilizers retracting into the transport position where guarding is not physically and economically practicable, warning notices shall be fitted. (See 7.2.13).

Trapping and shearing points need only be considered at those areas within reach of persons standing adjacent to the HP at ground level, at control positions or at other points of access.

Verification: by visual examination.

5.3.18 The position of controls for stabilizers with feet shall provide the operator with visual contact with the stabilizer(s) being operated.

Verification: by visual examination.

5.3.19 Guards shall be provided to prevent persons at control positions, standing adjacent to the HP at ground level or at other points of access, from reaching hot parts or dangerous parts of drive systems. Opening or removal of these guards shall only be possible by the use of tools or keys provided with the HP.

Verification: by visual examination.

5.3.20 Any locking pins shall be secured against unintentional disengagement and loss.

Verification: by visual examination.

5.3.21 The exhaust from internal combustion engines shall be directed away from control positions.

Verification: by visual examination.

5.3.22 The filling points of fuel and hydraulic oil tanks (other than fire resistant fluid tanks) shall be positioned to avoid any fire risk from spillage onto very hot parts e.g. engine exhausts. Where the risk cannot be avoided, easily accessible fire extinguishers shall be provided.

Verification: by visual examination.

5.3.23 When the distance between the ground and the floor of the lower control position exceeds 0,5 m, the HP shall be equipped with an access ladder. The height of the bottom step or rung from the ground shall not exceed 0,5 m. The steps or rungs shall divide equally the distance between the bottom step or rung and the floor of the lower control position. Each step or rung shall be at least 0,25 m wide, at least 25 mm deep horizontally, and shall be slip-resistant. The front of the steps or rungs shall be at least 0,15 m horizontally away from the supporting structure or any other components of the HP.

Hand holds, handrails or similar adequate devices shall be provided to facilitate climbing any access ladder. They shall be arranged to avoid the use of controls and piping for hand holds or foot-steps.

Verification: by visual examination and measurement.

5.3.24 Any driving seat shall enable the operator to maintain a stable position and be designed with due regard to ergonomic principles. The seat shall be designed to reduce vibrations transmitted to the operator to the lowest level that can be reasonably achieved. The seat mountings shall withstand all stresses to which they can be subjected. Where there is no floor beneath the operator's seat, the operator shall have footrests covered with a slip resistant material.

Verification: by visual examination.

5.3.25 Batteries used to power the HP shall be located and installed so as to avoid as far as possible the chance of electrolyte being ejected onto the operator in the event of rollover and/or to avoid the accumulation of vapours in places occupied by operators.

Verification: by visual examination.

5.3.26 An electrically conducting connection between the HP and the bearing surface shall be ensured during operation. For HPs which are constructed for operation with stabilizers, the jacking devices shall provide an electrically conducting connection between the HP and the bearing surface. Blocks shall conform to these requirements. ^(A1)

Verification: by visual examination.

5.4 Extending structure

5.4.1 Methods to avoid overturning and exceeding permissible stresses

5.4.1.1 General

For HPs with more than one combination of rated load and working envelope, avoidance of overturning and overloading the structure during operation shall be controlled by automatic control of the variable working envelopes of the extending structure (position control) and/or load moment, with appropriate information/indicators for the operator on the permitted number of persons on the platform where this is variable.

One or more of the following equivalent solutions indicated by a cross shall be provided.

Type	Load sensing system and position control (see 5.4.1.3 and 5.4.1.4)	Load and moment sensing system (see 5.4.1.3 and 5.4.1.5)	Moment sensing system with enhanced overload criteria (see 5.4.1.5 and 5.4.1.7)	Position control with enhanced stability and overload criteria (see 5.4.1.4, 5.4.1.6 and 5.4.1.7) NOTE HPs with one rated load
A	X			X
B	X	X	X	X

The conditions allowing omission of load measurement for HPs with one rated load are still under consideration. Before selecting the solution "Position control with enhanced stability and overload criteria", manufacturers must make a risk analysis in order to be able to demonstrate that there is no risk to the structure, or risk of overturning, due to overloading. This risk analysis may take into account that the structural calculation 5.2.5.2.1 includes the 150% rated load test (6.1.3) and that the stability calculation 5.2.4 includes not only the effects of the mass of the extending structure etc. but also the dynamic factors, which may not be present in a rescue situation where the overload risk is greatest.

5.4.1.2 Combinations of rated load

On HPs with separate combinations of rated load and working envelope, pre-selection of each combination by manual means giving automatic control of the working envelope is acceptable. The rated load for the selected combination shall be indicated at the extending structure control positions, but selection shall only be possible if the platform is in the working envelope for the new selected rated load.

Where there is more than one rated load, the HP shall be fitted with load and moment sensing systems (see 5.4.1.3 and 5.4.1.5) or load sensing system and position control (see 5.4.1.3 and 5.4.1.4).

5.4.1.3 Load sensing system

The load sensing system shall meet with the following requirements:

- To prevent all movements when the vertical load on the platform exceeds 120 % of the rated load,
- To provide a warning when the vertical load on the platform exceeds 120 % of the rated load. The warning shall consist of a continuously flashing red light and an acoustic signal which sounds for periods of at least 15 seconds every minute.

An over-ride device shall be provided at each control position to permit further movement within the working envelope after the load sensing system has operated. An over-ride device shall require continuous positive action by the operator.

5.4.1.4 Position control

5.4.1.4.1 General

The working envelope of the extending structure shall be limited automatically to avoid overturning, or overloading the structure of the HP. This also applies where stabilisers have variable positions which affect the working envelope of the extending structure.

5.4.1.4.2 Mechanical limiting systems

Where permissible positions are limited by mechanical stops these shall be of sufficient strength to absorb the maximum force exerted. The ends of hydraulic cylinders, if properly constructed for the purpose, fulfil this requirement. Mechanical devices/systems shall be designed and installed to provide safety levels equivalent to those specified for electrical/electronic systems. This requirement is fulfilled if the components e.g. rods, levers, wire ropes and chains etc are designed to take at least twice the load imposed on them.

5.4.1.4.3 Non-mechanical limiting systems

Where non-mechanical limiting systems are used, permissible positions shall be limited by devices/systems which measure positions of the extending structure or which determine the overturning moment, and operate through the control systems to limit movements to the positions/overturning moments permitted by the manufacturer.

5.4.1.4.4 Hydraulic/pneumatic parts of these devices/systems acting directly on full flow valves of hydraulic/pneumatic systems do not need to be duplicated if failure of one component does not cause a dangerous situation, but pilot operated control valves in these devices/systems shall be so designed and installed that they fail to safety, e.g. they stop any further movement, in the event of power failure.

5.4.1.4.5 Where these devices/systems operate through electric limit switches these shall have an operating life equivalent to at least twice the number of load cycles for which the HP is designed and shall be installed in protected places where they can be inspected easily. They shall be backed up by ultimate limit switches to EN 60947-5-1, i.e. with positive separation of their circuit breaking contacts. Operation of the ultimate limit switch shall stop all movements, thus indicating a failure of the limit switch.

Other types of switch, including proximity switches, shall only be used where the system safety integrity will be equivalent to that achieved by using limit switches and ultimate limit switches according to this clause.

5.4.1.4.6 In electronic limit measuring devices/systems, the following shall be taken into account:

Should a fault occur, the device or system shall fail to a safe condition, i.e. avoiding overturning, or overloading the structure of the HP.

All hardware devices, with the exception of audible and visual devices and displays and data input switches, the failure of which would cause the device/system to fail or malfunction in a manner that would not be immediately obvious to the operator, shall be automatically monitored.

The operation of transducers, associated conductors and connections shall be monitored for out-of-range conditions.

Sensors measuring the same parts of the HP shall be duplicated, and monitored by the device/system. Unacceptable differences between the two sensors monitored by the device/system shall create a safe condition. If sensing different parts of the HP the output signals shall be compared to provide equivalent safety.

If continuous monitoring is not possible the correct operation of the device/system shall be self-verifying at start-up.

5.4.1.4.7 Verification of 5.4.1: by design check and functional test.

5.4.1.5 Moment sensing system

The moment sensing system shall meet the following requirements:

- a) The operator is warned by an automatic warning device when the permissible moment is reached (see 5.2.4). The warning shall consist of a continuously flashing amber light.
- b) The system shall, when the permissible moment is reached, prevent any movement which increases the overturning moment.

5.4.1.6 Enhanced stability criteria

To meet the requirement of enhanced stability, the HP shall be designed according to the following criteria:

- a) Outside dimensions of the platform in any horizontal section:
 - minimum dimension 0,7 m and maximum surface area 0,6 m² per person forming part of the rated load.
- b) For the static test described in Clause 6.1.2, the test load shall be increased to 150 % of the rated load if the calculated figure is less than 150 %.

5.4.1.7 Enhanced overload criteria

To meet the requirement of enhanced overload, the HP shall be designed according to the following criteria:

- a) Outside dimensions of the platform in any horizontal section:
 - minimum dimension 0,7 m and maximum surface area 0,6 m² per person forming part of the rated load.
- b) For the overload test described in Clause 6.1.3, the test load shall be 150 % of the rated.

5.4.2 When parts of the extending structure need to be operated in a specific sequence to avoid instability, this sequence shall be controlled automatically.

Verification: by design check and functional test.

5.4.3 HPs with extending structures which incorporate masts which must be tilted to a fixed working position for use shall be equipped with a device to ensure that the mast is locked in the working position before further movement is possible.

Verification: by functional test.

5.4.4 Trapping and shearing points between parts of the extending structure, the base and platform shall be avoided by providing safe clearances in accordance with EN 349 or adequate guarding. For areas such as turntables crossing stabilizers/chassis and resting points for extending structures in the travel condition, where guarding is not possible but the areas can be seen from the control position, warning notices shall be fitted (see 7.2.13).

Verification: by visual examination.

Trapping and shearing points need only be considered at those areas within reach of persons on the platform or at control positions or standing adjacent to the HP at ground level.

5.4.5 Ladders

On ladders with rails on each side the minimum width between the side rails of any ladders shall be 305 mm. On ladders with one side rail the width between the side rail and the extending structure shall be 400 mm minimum. The height of the side rails or the extending structure above the rounds shall be a minimum of 280 mm. The rounds of the ladders shall be spaced at intervals of 280 mm to 310 mm maximum. Any gap between ladders with one side rail and the extending structure shall be a maximum of 100 mm.

Verification: by measurement.

5.5 Extending structure drive systems

5.5.1 General

5.5.1.1 Drive systems shall be designed and constructed with brakes, automatic locks or self-sustaining devices to prevent any inadvertent movements of the HP and shall ensure that the platform, loaded with the rated load(s) + 10 %, can be stopped and held at any position under all possible conditions of operation.

Verification: by design check and functional test 6.1.5.1.3.

5.5.1.2 If the power source is capable of producing greater power than the extending structure and/or platform drive system requires, protection shall be provided to the extending structure and/or platform drive system. e.g. by a pressure limiting device. The use of friction couplings does not fulfil the requirement.

Verification: by design check.

5.5.1.3 Transmission chains or belts shall only be used in drive systems provided inadvertent movements of a platform are automatically prevented if failure of a chain or belt occurs.

Verification: by design check.

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

Verification: by design check and visual examination.

5.5.1.5 If powered and manual drive systems are provided for the same movement, interlocks shall prevent both systems from being engaged at the same time if this would create a hazard. This shall not apply to controls used only for emergency operation.

Verification: by design check.

5.5.2 Wire rope drive systems

5.5.2.1 Wire ropes

5.5.2.1.1 Load carrying ropes shall be made from galvanized steel and have the following characteristics:

- diameter: 6 mm minimum
- number of wires: 114 minimum
- tensile grade of the wires: 1570 N/mm² minimum,