

Cranes — Loader cranes

ICS 53.020.20

National foreword

This British Standard is the UK implementation of EN 12999:2002+A2:2006. It supersedes BS EN 12999:2002+A1:2004 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated 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.

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ICS 53.020.20

English version

Cranes - Loader cranes

Appareils de levage à charge suspendue - Grues de
chargement

Krane – Ladekrane

This European Standard was approved by CEN on 8 March 2001.

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Foreword

This document (EN 12999:2002) has been prepared by Technical Committee CEN /TC 147, Cranes — Safety, 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of an identical text or by endorsement, at the latest by March 2003 and conflicting national standards shall be withdrawn at the latest by March 2003.

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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this document: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This document (EN 12999:2002/A1:2004) has been prepared by Technical Committee CEN/TC 147, Cranes — Safety, the secretariat of which is held by BSI.

This Amendment to the European Standard EN 12999:2002 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

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).

To ensure the safety of normal operation, maintenance and inspection, additional provisions are necessary which are not yet described in this Standard.

This amendment covers the necessary additional precautions by replacing the relevant existing text of EN 12999:2002.

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Foreword to amendment A2

This document (EN 12999:2002/A2:2006) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by BSI.

This Amendment to the European Standard EN 12999:2002 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2006, and conflicting national standards shall be withdrawn at the latest by October 2006.

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).

The provisions of this amendment shall not be mandatory to cranes manufactured the first 12 months after the date of availability of the amendment. The provisions concerning stress calculations shall not apply to cranes designed before the date of availability of the amendment.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, 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 European Standard is a harmonised standard to provide one means for loader cranes to conform to the essential health and safety requirements of the Machinery Directive 98/37/EEC.

This European Standard is a type C standard as stated in EN 1070.

The machinery concerned and the extent to which hazards are covered are indicated in the scope of this standard.

1 Scope

This European Standard specifies minimum requirements for design, calculation, examinations and tests of hydraulic powered loader cranes and their mountings onto vehicles or static foundations.

This standard does not apply to loader cranes used on board ships or floating structures and to articulated boom system cranes which are designed as total integral parts of special equipment such as forwarders.

The hazards covered by this standard are identified in clause 4.

This standard does not cover hazards related to the lifting of persons.

This standard applies to loader cranes (including timber handling cranes) which are manufactured after the date of approval by CEN of this standard.

NOTE 1 Winches will be covered by a special standard being in preparation by CEN/TC 147.

NOTE 2 The use of cranes for the lifting of persons may be subject to specific national regulations.

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.

Text deleted 

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

EN 349:1993, *Safety of machinery – Minimum distances to avoid crushing of parts of the human body.*

EN 811:1996, *Safety of machinery – Safety distances to prevent danger zones being reached by the lower limbs.*

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

EN 982:1996, *Safety requirements for fluid power systems and components - Hydraulics*

EN 1070:1998, *Safety of machinery - Terminology*

EN 12077-2:1998, *Cranes safety – Requirements for health and safety – Part 2: Limiting and indicating devices*

EN 12644-1:2001, *Cranes – Information for use and testing – Part 1: Instructions*

EN 12644-2:2000, *Cranes – Information for use and testing – Part 2: Marking*

 EN 13001-1:2004, *Cranes — General design — Part 1: General principles and requirements*

EN 13001-2:2004, *Cranes — General design — Part 2: Load actions*

CEN/TS 13001-3-1:2004, *Cranes — General design — Part 3-1: Limit states and proof of competence of steel structures* 

prEN 13557:1999, *Cranes - Controls and control stations*

prEN 13586:1999, *Cranes - Access*

 *Text deleted* 

EN 60204-32:1998, *Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines.*

Ⓐ₂ EN 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2:1999, modified)*

EN 61000-6-4:2001, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:1997, modified)* Ⓐ₂

EN ISO 5353:1998, *Earth-moving machinery and tractors and machinery for agriculture and forestry — Seat index point (ISO 5353:1995)*

Ⓐ₂ EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (EN ISO 12100-1:2003)*

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

Text deleted Ⓐ₂

3 Terms and definitions

3.1 Definitions

For convenience of reference the definitions are - with the exception of 3.1.1 loader crane - grouped in alphabetical order in the English version.

For the purposes of this standard, the definitions given in EN 1070:1998 apply, together with the following:

3.1.1

loader crane

powered crane comprising of a column, which slews about a base, and a boom system which is attached on to the top of the column. The crane is usually fitted on a vehicle (including trailer) and is designed for loading and unloading the vehicle.

NOTE 1 A crane, as defined above, installed on a static foundation is still considered a loader crane.

NOTE 2 Annex A give examples of configuration and mountings.

3.1.2

articulated

movement of boom members pivoting about a pin joint

3.1.3

base

housing incorporating anchoring points and bearings for the slewing column

3.1.4

boom

structural member in the boom system of the loader crane

3.1.5

boom extension, hydraulic

part of the boom which is capable of hydraulic telescopic movement to vary its length

3.1.6

boom extension, manual

part of the boom which can be manually extended or retracted

3.1.7

boom system

complete system, consisting of booms, boom extensions and cylinders

3.1.8**column**

structural member which supports the boom system

3.1.9**control system**

interface between the operating levers and the actuating components which provide movements of the loader crane

3.1.10**control station**

position from which the loader crane may be operated

3.1.11**danger zone**

any zone within and/or around the machinery in which a person is exposed to risk of injury or damage to health. (EN 1070:1998)

3.1.12**dead loads**

forces due to the masses of the fixed and movable crane parts which act permanently on the structure while the crane is being used

3.1.13**dynamic pressure**

pressure in a hydraulic system component or part of hydraulic system caused by dynamic forces on actuators when handling the load

3.1.14**fixed load lifting attachment**

equipment from which the net load may be suspended and which is fitted directly to the boom head as an integral part of the crane. This comprises e.g. hooks, grabs,

3.1.15**flow sensitive check valve**

valve which stops the flow when a pre-set pressure drop level is exceeded

3.1.16**gross load**

sum of payload, lifting attachments and if applicable a portion of the hoist rope

3.1.17**high seat**

control station connected to the column, consequently rotating with the crane

3.1.18**hydraulic line rupture**

failure of a hydraulic line which results in a loss of pressure in the line

3.1.19**load holding valve**

valve which is normally closed and is opened by an external force to allow the flow of fluid out of a hydraulic actuator

3.1.20**main relief valve**

valve which limits the pressure supplied to the hydraulic system of the crane

3.1.21**maximum working pressure**

maximum pressure in pump circuit or individual working function

3.1.22

net lifting moment

rated capacity multiplied by outreach

3.1.23

non-fixed load lifting attachment

interchangeable equipment which can be fitted directly or indirectly to the hook or any other coupling device of a crane by the user without affecting its integrity

3.1.24

outreach

the horizontal distance between the axis of rotation of the boom/boom system/jib in a vertical plane and point of load attachment.

3.1.25

outreach, hydraulic

outreach which can be obtained with hydraulically actuated parts of the boom system

3.1.26

payload

load, which is lifted by the crane and suspended from the non-fixed load-lifting attachment(s) or, if such an attachment is not used, directly from the fixed load-lifting attachment(s)

3.1.27

port relief valve

valve which limits the pressure supplied to a hydraulic actuator

3.1.28

pressure relief valve

valve which automatically relieves the hydraulic oil to the tank when the pressure exceeds a specified value

3.1.29

raised control station

control station at a height above the ground level, i.e. a high seat attached to the column of the loader crane or a platform positioned above the base of the loader crane (see annex K)

3.1.30

rated capacity

load that the crane is designed to lift for a given operating condition (e.g. configuration, position of the load)

3.1.31

rated capacity indicator

device which gives, within specified tolerance limits, at least a continuous indication that the rated capacity is exceeded, and another continuous indication (on certain crane types) of the approach to the rated capacity

3.1.32

rated capacity limiter

device that automatically prevents the crane from handling loads in excess of its rated capacity, taking into account the dynamic effects during normal operations use

3.1.33

setting-up function

crane function used to prepare the crane for lifting

3.1.34

sink rate

distance in a given time at which the load lowers due to internal leakage of hydraulic components

3.1.35

slewing

rotational movement of the column and boom system about a vertical axis

3.1.36

stabilizer

aid to the supporting structure connected to the base of the crane or to the vehicle to provide stability, without lifting the vehicle from the ground

3.1.37

stabilizer extension

part of the stabilizer capable of extending the stabilizer leg laterally from the transport position to the operating position

3.1.38

stabilizer leg

part of a stabilizer capable of contacting the ground to provide the required stability

3.1.39

static foundation

fixed support incorporating mounting points for a crane

3.1.40

timber handling crane

loader crane specifically designed, manufactured and equipped with a grapple for loading/unloading of unprepared timber (e.g. tree trunks, branches). The operator controls the crane from a high seat or from a cabin.

3.1.41

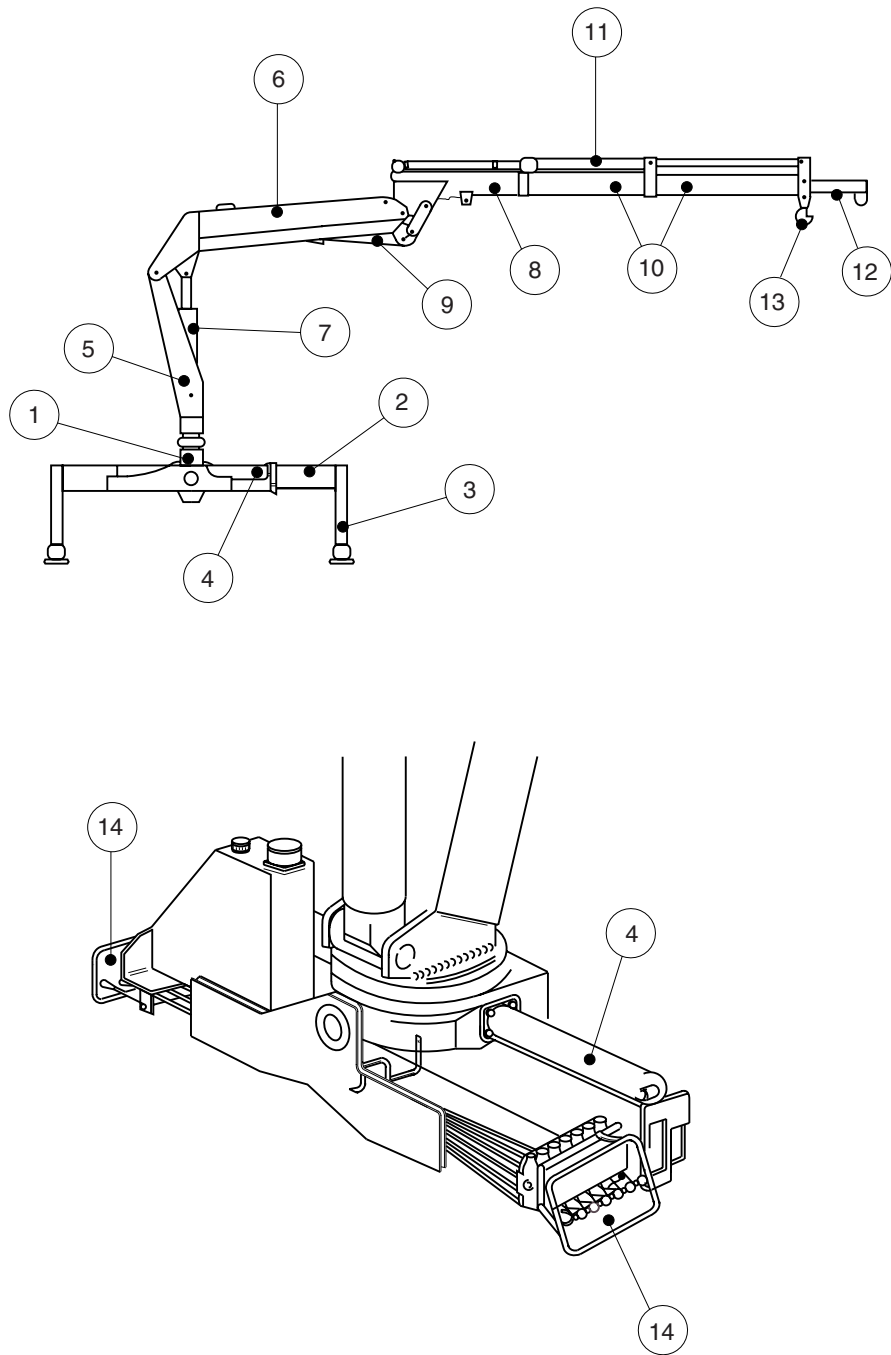
total lifting moment

sum of net lifting moment and the moment produced by dead loads.

3.2 Terminology

The terms which are used in this standard for the main parts of a loader crane are indicated in figure 1.

Boom system consists of items 6-12.



Key			
1. Base	2. Stabilizer extension	3. Stabilizer leg	4. Slewing mechanism
5. Column	6. 1st boom	7. 1st boom cylinder	8. 2nd boom
9. 2nd boom cylinder	10. Boom extension, hydraulic	11. Extension cylinders	12. Boom extension, manual
13. Hook	14. Controls		

Figure 1 — Main parts of a loader crane

4 List of significant hazards

Table 1 shows a list of significant hazardous situations and hazardous events that could result in risks to persons during normal use and foreseeable misuse. It also contains corresponding cross-references to ~~A2~~Text the relevant clauses in this standard that are necessary to reduce or eliminate the risks associated with those hazards.

A2

Table 1 — List of significant hazards and associated requirements

No.	Hazards	Relevant clause(s) in this standard
Hazards, hazardous situations and hazardous events		
1	Mechanical hazards due to:	
	– Inadequacy of mechanical strength of the crane and its parts	5.1, 5.2, 5.3, 5.5.1, 5.5.4, 5.5.5, 5.5.8, 5.5.9, 5.8.2.1, 5.8.2.2, 5.10.2.1, 5.10.2, 7.2.3.7
1.1	Crushing hazard	5.8.1, 5.8.2.2, 5.8.2.3, 5.10.2.3
1.2	Shearing hazard	
1.3	Cutting or severing hazard	
1.4	Entanglement hazard	
1.5	Drawing-in or trapping hazard	
1.6	Impact hazard	
1.7	Stabbing or puncture hazard	
1.8	Friction or abrasion hazard	
1.9	High pressure fluid injection or ejection hazard	5.5.1, 5.5.5, 5.10.7, 7.2.3.5, 7.2.4.2
1.10	Ejection of parts	5.4.1.1, 5.4.1.2, 5.4.1.3, 5.4.2, 5.4.3
1.11	Loss of stability	5.6.1, 5.6.2, 5.6.4, 5.6.5, 5.6.6.2, 5.10.3
1.12	Slip, trip, fall	5.8.2.2, 5.8.2.3, 5.8.2.4, 5.10.8
2	Electrical hazards due to:	
2.1	Contact of persons with live parts (direct contact)	5.6.1.3, 5.9, 5.10.6, 7.2.3.1d)
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	
2.3	Approach to live parts under high voltage	
2.4	Electrostatic phenomena	
2.5	Thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads, etc	



Table 1 — List of significant hazards and associated requirements (continued)

No.	Hazards	Relevant clause(s) in this standard
3	Thermal hazards, resulting in:	
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	5.5.5, 5.10.2.3, 7.2.4.1
3.2	Damage to health by hot or cold working environment	7.2.3.7
4	Hazards generated by noise	"Not significant for cranes that do not include the power source. See 7.2.3.8 regarding information on noise."
5	Hazards generated by vibration	5.10.5
7	Hazards generated by materials and substances (and their constituent elements) processed or used by the machinery	5.10.2.3
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	7.2.4.1
8	Hazards generated by neglecting ergonomic principles in machinery design, as e.g. hazards from:	
8.1	Unhealthy postures or excessive effort	5.4.1.3, 5.4.2, 5.4.3, 5.7, 5.8, 5.10.8
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	5.7, 5.8
8.3	Neglected use of personal protection equipment	7.2.4.1
8.4	Inadequate local lighting	5.8.1, 7.2.4.1, 7.2.3.6d)
8.6	Human error, human behaviour	5.6, 5.7.1, 5.7.2, 7.2.3, 7.2.4
8.7	Inadequate design, location or identification of manual controls	5.4.1.3, 5.4.3, 5.7, 5.8
8.8	Inadequate design or location of visual display units	
9	Combination of hazards	5.2.3, 5.2.4
10	Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) from:	
10.1	Failure/disorder of the control system	5.5.6.1, 5.5.6.2, 5.5.7, 5.6.6, 5.6.8, 5.7.1





Table 1 — List of significant hazards and associated requirements (continued)

No.	Hazards	Relevant clause(s) in this standard
11	Hazards caused by missing and/or incorrectly positioned safety related measures/means	
11.1	Guards	5.5.5, 5.7.1, 5.8.2.2, 5.8.2.3, 5.10.2.3
11.2	Safety related (protection) devices	5.4.1, 5.4.3, 5.6.3, 5.6.6, 5.6.7
11.4	Safety signs, signals, symbols	5.4.1.3, 5.6.7, 5.7.2, 7.2.3.5, 7.3.4, 7.3.5
11.5	Information or warning devices	5.6.1, 5.6.2, 5.6.4, 5.6.7, 7.1, 7.2, 7.3
11.6	Visibility	5.4.3, 5.8.1, 7.3.4.1
11.7	Emergency devices	5.6.3, 5.6.8
15	Assembly errors	7.2.2, 7.2.4
18	Loss of stability/overturning of machine	5.4.1, 5.6.1, 5.6.2, 5.6.4, 5.6.5, 5.6.6, 5.10.3
Additional hazards, hazardous situations and hazardous events due to lifting		
27	Mechanical hazards and hazardous events	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.10.3, 6.2.5
27.1.2	Uncontrolled loading – overloading – overturning moments exceeded	5.5.4, 5.6.1, 5.6.2, 5.6.3, 5.6.4, 5.6.5
27.1.3	Uncontrolled amplitude of movements	5.6.6
27.1.4	Unexpected/unintended movement of loads	5.5.6, 5.5.7, 5.5.8
27.1.5	Inadequate holding devices/accessories	5.4.2, 7.2.3.6
27.2	From access of persons to load support	1, 7.2.3.1e)
27.4	From insufficient mechanical strength of parts	5.1, 5.2, 5.3, 5.5.8, 5.5.9, 5.10.2
27.8	From abnormal conditions of assembly/testing/use/maintenance	5.10, 7.1, 7.2, 7.3
29	Hazards generated by neglecting ergonomic principles	
29.1	Insufficient visibility from the driving position	5.8.1



5 Safety requirements and/or safety measures

5.1 General

Machinery shall conform to the safety requirements and/or measures of this clause. In addition, the machine shall be designed according to the principles of A_2 EN ISO 12100 A_2 for hazards relevant but not significant which are not dealt with by this standard.

The rated capacity shall be calculated from the following:

- a) the working pressure in the cylinders;
- b) the area of the load carrying cylinders;
- c) the geometry;
- d) dead loads;
- e) load combinations.

For the purpose of the calculations rated capacity is equal to gross load.

5.2 Structural calculation

5.2.1 Information to be given in the calculation

The following information shall be given in the calculation:

- a) type of crane and method of operation;
- b) the assumed number of all load or working cycles;
- c) details of the load-carrying system reflecting actual service conditions including outline drawings and principal dimensions;
- d) the assumed loading conditions including ground slope;
- e) A_2 the governing hoisting class, hoist drive class and stress history classes A_2
- f) the material for the individual components and joints;
- g) the shapes, dimensions and static cross-section values of all load-carrying members;
- h) the analyses separately for the individual structural components and essential connections.

5.2.2 Dynamic factors

5.2.2.1 Hoisting and gravity effects of the mass of the crane

A2 The dynamic effects due to vibrations of the structure when raising or lowering a load shall be taken into account by applying the factor ϕ_1 on the gravitational forces due to the masses of the crane. It shall be used for the design of the crane structure itself and its supports. The value of ϕ_1 shall be the lowest of the two values 1,1 and ϕ_2 , or expressed as an equation:

$$\phi_1 = \min(1,1 ; \phi_2) \quad \text{A2}$$

5.2.2.2 Hoisting and gravity effects of the gross load

A2 In the case of hoisting or grounding a load as well as starting or stopping a vertical motion, the hereby included vibrational effects shall be taken into account by multiplying the gravitational force due to the mass of the hoist load by a factor ϕ_2 .

The factor ϕ_2 shall be taken as follows:

$$\phi_2 = \phi_{2,\min} + \beta_2 \times v_h$$

$\phi_{2,\min}$ and β_2 are given in Table 2a for the appropriate hoisting class. Loader cranes are assigned to hoisting classes HC1 and HC2 according to their dynamic and elastic characteristics:

- HC1 for crane mounted on a vehicle or foundation of equivalent flexibility;
- HC2 for crane mounted on a static foundation.

v_h is the steady vertical hook speed, in meters per second, related to the lifting attachment. Values of v_h are given in Table 2b.

Table 2a — Value of β_2 and $\phi_{2,\min}$

Hoisting class of appliance	β_2	$\phi_{2,\min}$
HC 1	0,17	1,05
HC 2	0,34	1,10

Table 2b — Values of v_h

Load combination	Type of hoist drive and its operation method		
	HD1	HD4	HD5
A1, B1	$v_{h,\max}$	$0,5 \times v_{h,\max}$	$v_h = 0$
C1	-	$v_{h,\max}$	$0,5 \times v_{h,\max}$

where

HD1: hoist drive can only be operated at a fixed speed;

HD4: a step-less variable speed control can be operated by the crane driver;

HD5: after pre-stressing the hoist medium, the hoist drive control provides the reaching of a selected speed with an acceleration independent of the crane driver;

$v_{h,\max}$ is the maximum vertical hook speed.

In load combinations A1 and B1, $v_{h,\max}$ is the maximum vertical hook speed that is given by any single hydraulic drive action.

In load combination C1, $v_{h,\max}$ is the maximum vertical hook speed from all articulation hydraulic drives acting simultaneously. **A2**

5.2.2.3 Effect of sudden release of a part of the gross load

For cranes that release or drop a part of the gross load as a normal working procedure, such as when grabs or magnets are used, the peak dynamic effect on the crane can be simulated by multiplying the gross load by the factor Φ_3 .

The value is given by: $\Phi_3 = 1 - \Delta m \times (1 + \beta) / m$ where:

m the mass of the gross load;

Δm the released or dropped part of the gross load;

$\beta = 0,5$ for cranes equipped with grabs or similar slow-release devices;

$\beta = 1,0$ for cranes equipped with magnets or similar rapid-release devices.

5.2.2.4 Effects caused by acceleration/deceleration of the slewing drive

The dynamic factor Φ_{sh} shall have the value 1,05 for hook duty and 1,3 for bucket or grapple duty. 

5.2.3 Loads and forces

5.2.3.1 General

The following loads and forces shall be taken into account:

a) Regular loads:

- 1) dead loads;
- 2) gross load;
- 3) dynamic forces;
- 4) centrifugal forces;

b) Occasional loads:

- 1) in-service wind loads;
- 2) other climatic and environmental effects such as temperature, snow and ice;
- 3) loads on stairways, platforms and hand rails;

c) Exceptional loads:

- 1) test loads;
- 2) loads caused by movements suddenly stopped by a mechanical device, e.g. end stroke of slewing cylinder or a safety device, e.g. emergency stop, hydraulic line rupture valve;
- 3) sudden release of the load, e.g. rope failure, sling failure.

 4) forces due to simultaneous dynamic peaks caused by raising or lowering a load at the maximum sum of the vertical speeds from all articulation drives. 

5.2.3.2 Regular loads

5.2.3.2.1 Dead loads

See 3.1.12.

5.2.3.2.2 Gross load

See 3.1.16.

5.2.3.2.3 Forces due to acceleration/deceleration of the slewing drive

A_2 The horizontal load of the mass of the gross load shall be taken into account according to the following:

$$F_h = \frac{M}{R}$$

where

F_h is the horizontal load;

M is the gross slewing moment - (theoretical slewing moment with 100 % efficiency);

R is the outreach at calculated position. If $R < R_{\max} / 2$, the value $R = R_{\max} / 2$ is used in the equation for calculating F_h ;

$R_{\max}$ is the maximum hydraulic outreach. A_2

5.2.3.2.4 Centrifugal forces (see table 3)

The centrifugal forces acting on slewing cranes shall only be calculated from the dead load of the boom system components, the counterweight, if applicable, and the gross load without applying the factors mentioned in 5.2.2.2 or 5.2.2.3.

5.2.3.3 Occasional loads

5.2.3.3.1 Wind loads

A_2 Wind loads shall be calculated to EN 13001-2. Only in-service wind needs to be applied. A_2

5.2.3.3.2 Loads on stairways, platforms and hand rails

See 5.8.2.

5.2.3.3.3 Exceptional loads

Such loads may act in exceptional situations (e.g. testing, hydraulic line rupture).

5.2.4 Load combinations

5.2.4.1 Basic load combinations

Loads shall be combined to determine the stresses the crane will experience during normal operation. Basic load combinations are given in table 3.

NOTE In general, load combinations A cover regular loads, load combinations B cover regular loads combined with wind loads, and load combinations C cover regular loads combined with occasional and exceptional loads.

5.2.4.2 Load combinations to be covered (see table 3)

- A2** A1 and B1 Normal service conditions, raising/lowering loads with dynamic peak from any single hydraulic function while slewing: A1 without wind effects, B1 with wind effects.
- A2 and B2 Normal service conditions, with grapple, magnet or similar accessory allowing sudden release of a part of the gross load while slewing: A2 without wind effects, B2 with wind effects.
- C1 Simultaneous dynamic peaks caused by raising or lowering a load at the maximum sum of the vertical speeds from all articulation drives, taking into account the available oil flow.
- C3 Crane under test condition. **A2**

5.2.4.3 Application of table 3

A2 Basic load combinations for the calculation to prove that mechanical hazards from yielding and elastic instability from extreme values are prevented are given in Table 3.

For the proof of fatigue strength, load combinations A1 and A2, with all partial safety factors γ_p set to 1,00, shall be applied.

Table 3 — Load combinations to be covered

Categories of load	Loads		Load comb. A			Load comb. B			Load comb. C			Row
			γ_p	A1	A2	γ_p	B1	B2	γ_p	C1	C3	
Regular	Gravity, Acceleration of lifting drives	Moved masses of the crane	1,22	Φ_1	Φ_1	1,16	Φ_1	Φ_1	1,1	Φ_1	1,0	1
		Mass of the gross load	1,34	Φ_2	Φ_3	1,22	Φ_2	Φ_3	-	-	-	2
	Acceleration of slewing drive	Mass of the gross load	1,34	Φ_{5h}	Φ_{5h}	1,22	Φ_{5h}	Φ_{5h}	-	-	-	3
Occasional	Climate effects	In service wind load ^a	-	-	-	1,22	1	1	-	-	-	4
Exceptional	Forces due to one exceptional effect		-	-	-	-	-	-	1,1	Φ_2	1,0	5

^a Acceleration and retarding forces acting simultaneously with wind loads shall only be applied to such an extent that the drive forces in row 3 are not exceeded.

A2

5.3 Stress analysis

A2 The strength of the steel structure may be assessed according to CEN/TS 13001-3-1:2004 or according to the information given in Annex B. In the latter case, the partial load factors γ_p in Table 3 shall be set to 1.

The limit states given in CEN/TS 13001-3-1:2004 are to be used in conjunction with a static analysis that is made for all boom positions and for all crane configurations. **A2**

5.4 Mechanical arrangements

5.4.1 Stabilizers

5.4.1.1 General

A2 Stabilizers shall be provided when needed to fulfil the stability requirements (see 5.10.3) when loader cranes are fitted on vehicles.

NOTE Regarding stabilizer interlocks on loader cranes see explanatory note in informative Annex P. **A2**

5.4.1.2 Stabilizer leg

The stabilizer leg shall have means (e.g. feet) for ground support.

Stabilizer ground support shall be constructed to accommodate ground unevenness of at least 10°.

When the stabilizer leg has a tilting device, locking means which can withstand normal operational forces (e.g. pins) shall be provided to secure the leg in both the working and transport position (see 5.4.3).

5.4.1.3 Stabilizer extension

 Stabilizers extensions shall be marked to show when they are correctly deployed.

Manually operated extensions shall be fitted with:

- a) handles for the manual operation;
- b) devices for locking in the working and transport positions (see 5.4.3);
- c) pull out stops.

Locking means in the working position shall be fitted if the hydraulic cylinders are not able to resist the forces during load handling. 

5.4.2 Manual boom extensions

Manual boom extensions shall have pull out stops and mechanical locking means for their retracted and extended positions.

5.4.3 Securing for transport

5.4.3.1 General

Locking means shall be provided to prevent uncontrolled movements of the crane and stabilizers installed on vehicles when travelling.

Each of the stabilizer extension locking devices shall be designed to withstand, with no permanent deformation, the forces resulting from an acceleration of 2 g, applied in the direction of the movement.

5.4.3.2 Manually operated extensions

Manually operated stabilizer extensions shall be locked in the transport position by two separate locking devices for each stabilizer, at least one of these shall be automatically operated, e.g. a spring operated cam lock and an automatic spring latch. These shall be attached to the crane and/or stabilizers and be protected against unintentional removal, e.g. by locking pins with spring clips.

It shall be clearly visible to the operator when the manual locking devices are in the locked and unlocked position. In addition, a warning light, visible from the transport driving position, shall indicate when the stabilizers are not locked in the transport position.

5.4.3.3 Hydraulically operated extensions

Hydraulically operated stabilizer extensions shall be fitted with an automatic hydraulic or mechanical locking device for the transport position, in addition to a closed centre control valve. An automatic hydraulic locking device shall comprise check valves to prevent leakage and shall be directly connected to the cylinder or by means of steel pipes. A mechanical locking device shall be designed to withstand, without permanent deformation, the force due to the foreseeable misuse of attempting to extend the stabilizers with the locking devices engaged. 

5.5 Hydraulic system

5.5.1 General

The hydraulic system and components shall conform to the requirements as specified in EN 982:1996.

The hydraulic components and lines shall be sized such that the hydraulic system can be operated at the intended working pressure (including any pressure required during test procedures) without any failures and excessive temperatures being created.

Hydraulic systems shall be designed such that all components are compatible to each other and to the fluid being used in the system at specified environmental conditions. The hydraulic system shall have adequate filters to ensure that the fluid does not become contaminated.

Each hydraulic circuit shall be provided with means for checking the pressure.

5.5.2 Pump

A pump shall have the capacity to deliver the correct flow and pressure specified by the crane manufacturer for the hydraulic system when being driven at the specified speed. The pump size and its specified driven speed shall be chosen to ensure that the capacity of the power supplier is utilized efficiently.

NOTE See annex M for guidance on selecting the correct pump size.

The pump shall be suitable for the fluid specification used in the hydraulic system.

5.5.3 Hydraulic reservoir

The hydraulic reservoir shall be specified by the crane manufacturer and shall have sufficient fluid capacity for the pump to operate correctly when all the hydraulic cylinders are fully extended. There shall also be sufficient capacity for the fluid in the system when all the cylinders are retracted. Devices shall be incorporated to enable monitoring the maximum and minimum fluid level. An access opening and a drain valve with plug shall be provided for cleaning purposes.

5.5.4 Pressure relief valves

Each load carrying circuit shall be equipped with automatic means (e.g. port relief valves) which limit the pressure to a maximum of 25 % above the maximum working pressure or shall be designed to withstand the maximum pressure which can occur under the foreseen operating conditions.

The minimum setting of the pressure relief valves, except for timber handling cranes (see 5.6.2.1 and 5.6.2.2), shall be such that no uncontrolled movement can take place with loads up to 1,3 x the rated capacity.

5.5.5 Hoses, tubes and fittings

Burst pressure for hoses shall be minimum four times the maximum working pressure for hoses without end fittings. Burst pressure for tubes and fittings shall be minimum 2,5 times the maximum working pressure.

Hoses, tubes and fittings shall be so located, installed and, where appropriate, protected so that they do not get damaged by chafing, trapping etc.

Hydraulic hoses containing fluid with a pressure of more than 5 MPa and/or having a temperature over 50 °C and which are located within 1,0 m of the operator, shall be guarded.

Any part or component which may divert a possible jet of fluid can be considered as a sufficient protection device.

Hoses intended to withstand a pressure of more than 15 MPa shall not be fitted with reusable end fittings.

5.5.6 Precautions against hydraulic line rupture

5.5.6.1 Loader cranes other than timber handling cranes

All load carrying circuits shall be equipped with automatic means, e.g. load holding valves, to prevent uncontrolled movement of the crane in the case of hydraulic line rupture. Flow sensitive check valves shall only be used for equalizing and pressure sensing lines. The maximum flow through these lines shall not exceed 3 l/min.

Valves used for this means shall be close coupled to the cylinder. They shall be either:

- a) integral with the cylinder, or
- b) directly and rigidly flange mounted, or
- c) placed close to the cylinder or connected to it by means of short rigid pipes having welded, flanged or threaded connections.

For tubes and fitting between lock valve and actuator the safety factor shall be 2,5 calculated against the maximum dynamic pressure.

5.5.6.2 Timber handling cranes

In the event of hydraulic line rupture the lowering speed of the load shall not exceed the maximum lowering speed at rated capacity by more than 30%. (see explanatory note to 5.5.6.2 in informative annex C).

Stabilizer leg cylinders shall be equipped as specified in 5.5.6.1.

5.5.7 Sink rate for boom system

The sink rate measured at the boom system tip caused by leakage in hydraulic components shall not exceed 0,5 % of outreach per minute. For timber handling cranes, however, the sink rate may be 2 % of outreach per minute.

Sink rate shall be tested at maximum rated capacity and at maximum hydraulic outreach. (i.e. without manual extensions).

5.5.8 Slewing mechanism

The slewing mechanism shall be able to withstand the maximum slewing forces (see 5.2.3.3.3) to bring it to a stop and sustain the load under the most adverse operating conditions.

5.5.9 Calculation of hydraulic cylinders

Hydraulic cylinders shall be calculated for dynamic working pressure with a safety factor against the yield stress of minimum 1,5.

5.6 Limiting and indicating devices

5.6.1 General

5.6.1.1 Rated capacity limiters and indicators shall be provided on all cranes having a rated capacity of 1 000 kg or above, or a maximum net lifting moment of 40 000 Nm or above due to the load. The rated capacity shall be determined at all outreaches corresponding to the boom system being horizontal.

Rated capacity limiters/indicators shall conform to EN 12077-2:1998. Safety related parts of limiting and indicating systems shall conform to EN 954-1:1996 category 1 except for electronic parts of the system for limiting devices which shall conform to EN 954-1:1996 category 2.

The rated capacity limiter for a loader crane generally has three different tasks to fulfil:

- 1) prevent the structure from being overloaded;
- 2) prevent the risk of overturning of the vehicle;
- 3) prevent dangerous movements of the load.

All movements that will reduce the loading on the crane shall always be available.

NOTE Regarding rated capacity limiters on loader cranes see also explanatory note to 5.6 given in informative annex C. For examples of dangerous movement for different crane types see informative annex D.

For loader cranes with a rated capacity of less than 1 000 kg or a maximum net lifting moment of less than 40 000 Nm the relief valves according to 5.5.4 and 5.6.5 shall provide overload protection when a rated capacity limiter is not provided. The provision of a clearly marked pressure gauge showing the approach to the rated capacity, visible from the operators station, will fulfil the function of a rated capacity indicator for these cranes.

5.6.1.2 If the rated capacity is lower in sectors of the slewing range the crane shall be provided with slew limiters. These shall operate to override the controls of the crane when attempting to slew into this sector with a load higher than the rated capacity or lift loads above the rated capacities within the sector. The rated capacity indicator/limiter shall operate in all sectors of the slewing range.

5.6.1.3 When the boom system of a vehicle mounted loader crane is to be parked on the load platform or on top of the load during transport, an indicator (e.g. angle sensor) shall be provided. This indicator shall inform the operator when the crane height exceeds a predetermined maximum (as described in 7.2.3.3).

5.6.1.4 Cranes equipped with stabilizers shall be provided with a level indicator in clear view of the operator at the stabilizer control station.

5.6.1.5 For cranes, equipped with a winch, the winch shall be included in the system of the rated capacity limiter.

5.6.1.6 For cranes equipped with manual extensions, these extensions shall be included in the system of the rated capacity limiter. A mode selector may be provided to select the boom system configuration on the limiting and indicating device when manual extensions are fitted.

5.6.2 Rated capacity limiter

5.6.2.1 The rated capacity limiter shall operate within the designed operating accelerations of the crane between 100% and $(100 + \Delta\%)$ of the rated capacity. The value of Δ depends on hydraulic outreach according to the following formula:

$$\Delta \leq 8 + 0,5 R \leq 20$$

where:

R = hydraulic outreach in metres

For timber handling cranes, the tolerance 20% may be used independent of the hydraulic outreach.

NOTE It is generally accepted that a capacity limiter for loader cranes limits the load moment. At long outreach the main part of the total lifting moment comes from the dead loads and only a small part from the payload. Tolerances for the capacity limiter as stated above have been set taking this into account.

5.6.2.2 For timber handling cranes port relief valves with tolerances according to 5.6.2.1 shall provide overload protection when a rated capacity limiter is not provided.

5.6.3 Lowering facility

In order to avoid locking in of the loader crane, a lowering facility may be provided. This facility shall not allow any movement which may lead to a component failure or a loss of stability.

If this facility is fitted it shall be clearly identified. This facility shall only function whilst the control is held by the operator and for a period of maximum 5 seconds at intervals not shorter than 30 seconds .

5.6.4 Rated capacity indicators

The rated capacity indicator shall give a warning to the operator when the load exceeds 90% of the rated capacity. If the rated capacity is being exceeded there shall be a separate warning for overload to the operator and persons in the vicinity of the crane.

There shall be a clear difference between the warning for approach to rated capacity and the warning for overload. Both warnings shall be continuous and shall be distinguishable as a warning to the persons concerned whilst the crane is being operated.

The warning of persons in the danger zone is not appropriate for a loader crane with an outreach less than 12 m.

5.6.5 Main relief valve

All loader cranes shall be fitted with one or more main relief valves.

The main relief valve shall operate within the designed operating accelerations of the crane between 100 % and 110 % of the rated capacity.

5.6.6 Performance limiters

5.6.6.1 Motion limiters

Slewing, raising/lowering and telescoping motion limits shall be determined by the stroke of the cylinder or by appropriate stops.

5.6.6.2 Speed limiters

Speed limiters shall be incorporated into the slewing, raising/lowering and telescoping motion to ensure that any forces resulting from these motions are restricted to the design criteria of the loader crane.

5.6.7 Acoustic warning

 When a crane has a remote control system or a boom system having an outreach greater than 12 m, an audible warning device, e.g. klaxon, shall be provided. The audible warning device shall be capable of being actuated by the operator from each control station unless the control station is solely used for operating the stabilizer functions. .

5.6.8 Stopping device

A control device to bring the loader crane safely to a complete stop, by removing the energy supply to the crane shall be fitted at every control station unless the control station is solely used for operating the stabilizer functions. The device shall initiate the stop function by de-energizing and shall be designed, fitted and function according to the following:

- a) it shall be easily visible by red coloured actuators, where practicable in front of an yellow background;
- b) activating the device shall not require any decision by the operator about the resultant function and effects, e.g. mushroom-type push button;
- c) the actuator shall be arranged for easy access and for non-hazardous operation by the operator;
- d) after stopping the crane no further dangerous movements of the boom system shall appear;
- e)  the actuator shall lock-in where operated. 

5.7 Controls

5.7.1 General

The requirements below specify arrangement and direction of movements of controls assigned to working functions, such as slewing column, raising/lowering boom. Stabilizer functions are also included.

The requirements cover bi-directional and multidirectional (joy-stick) control levers.

The layout order of bi-directional controls has to follow the sequence of working functions from the base of the loader crane to the load handling device. Control levers for setting-up functions shall be separated by space or clearly distinguished (other than symbols) from other control levers.

All controls shall return automatically to the control position when they are released. They shall be marked permanently with clearly visible symbols as given in 5.7.2

All controls shall be in accordance with the safety and ergonomic principles as specified in prEN 13557:1999. Control levers shall be guarded against unintended operation.

5.7.2 Symbols

Symbols for the working and setting up functions of loader cranes having boom systems with two articulated booms shall be in accordance with annex E. For loader cranes having other boom systems, any additional symbols that are necessary shall be derivatives of annex E. The symbols shall be used as follows for bi-directional control levers:

- on the control lever knobs: Inside arrows indicate the movement of the corresponding lever. Only one symbol for a crane function and one arrow for the lever movement shall be combined. See figure 2;
- when placed on a separate plate adjacent to the control levers, the symbols can be used without lever movement arrows. Two symbols for each lever can be used. See informative annex G, figure G.3.
- the minimum size of a symbol shall be that it is circumscribed by a 15 mm circle. In the case of multi-symbols the minimum size shall relate to the smallest e.g. according to figure 2.

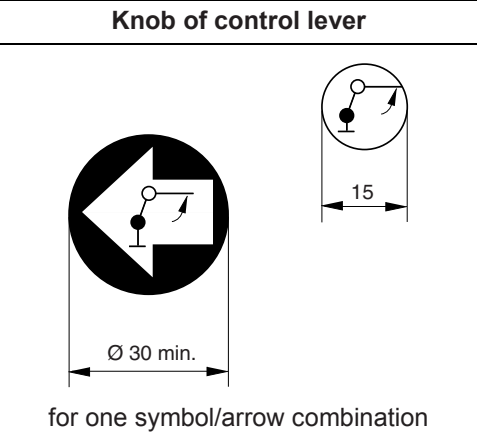
Knob of control lever	Meaning of symbol/arrow combination
	Move control lever to the left to raise second boom and Move control lever to the right to lower second boom

Figure 2 — Symbols for working function

5.7.3 Layout of bi-directional controls

5.7.3.1 General

The principles laid down in 5.7.1 apply to both vertical and horizontal control lever arrangements.

5.7.3.2 Vertical layout order

Information is given in annex F regarding the layout order for vertical control lever arrangements operated from ground level.

5.7.3.3 Horizontal layout order

Information is given in annex G regarding the layout order for horizontal control lever arrangements operated from ground level.

5.7.4 Guidance for high seat controls

Information is given in annex H.

5.8 Control stations

5.8.1 General

Control stations can be of the following types:

- a) ground control;
- b) raised control from fixed platform, slewing platform, high seat or cabin;
- c) remote control;
- d) cabin.

When more than one control station is provided there shall be means preventing simultaneous operation from two stations unless the controls are mechanically linked to each other (see explanatory note to 5.8 in informative annex C).

The control station for stabilizer extension function shall be positioned so that the operator has an unobstructed view of the movements being controlled.

A₂ Control stations shall be provided in such a way that the operator cannot be crushed or his clothing become trapped due to moving parts of the crane. With the exceptions listed below in this subclause, the safety distances of EN 294:1992 and EN 811:1996 shall apply. Where any guards are provided these shall not (unless specifically designed for the purpose) be able to be used to support the operators weight or be used as hand holds.

Where it is not practicable to install guards, gaps between moving parts shall conform to the dimensions given in appropriate standards for the prevention of finger, hand and foot trapping (see EN 349:1993).

For areas such as:

- stabilizers moving into transport position;
- resting points for boom system moving into transport position;
- control platform and moving column;
- high seat and moving first boom

where neither safe clearance in accordance with EN 349:1993 nor guarding according to EN 294:1992 or EN 811:1996 is possible, warning notices shall be fitted. However, control stations shall be placed so that the use of the controls does not require the operator to reach into danger zones, where risk of shearing and trapping exists. **A₂**

All control stations shall be in accordance with prEN 13557:1999.

Vehicle mounted loader cranes are generally operated for short periods and therefore a cabin is not normally required. For applications when a cabin is required, due to e.g. environmental conditions, the specification shall conform to prEN 13557:1999 with the exceptions as specified in annex J.

5.8.2 Raised control stations

5.8.2.1 Strength of components

Handrails shall withstand a horizontal force of 300 N distributed over 100 mm. Platforms shall withstand a force of 1 500 N applied on a circular area diameter 125 mm at any location on the surface. Steps and rungs shall withstand a force of 1 500 N applied over 100 mm. The components shall resist these applied forces without any permanent deformation and without any elastic deformation greater than 2% of the span between supports or 10 mm whichever is the lesser.

5.8.2.2 High seat (see informative annex K)

The construction and mounting of a high seat shall be according to the following requirements:

- a) accessibility to the seat shall not be inhibited by the controls or configuration of the loader crane in predetermined positions;
- b) the seat with supporting members fixing the seat to the loader crane shall withstand a force of 1 500 N acting centrally on the horizontal area of the seat without permanent deformation;
- c) horizontal positions shall be adjustable and lockable without the use of tools;
- d) the seat shall be provided with means to reduce the risk of falling when the operator is in working position. This shall not impair accessibility to the seat. If sideguards are fitted these shall be at a height of minimum 100 mm from the seat index point as defined in EN ISO 5353:1998.
- e) guards shall be provided to prevent moving parts of the loader crane trapping the operator or his clothing;
- f) a platform shall be provided for the operator's feet. Minimum dimension 160 mm x 300 mm for each foot.

5.8.2.3 Platform (see informative annex K)

The construction of a platform shall fulfil the following requirements:

- a) during operation the operator shall be protected against moving parts of the crane. Guards and/or limitation of the slew angle shall be provided when appropriate;
- b) the floor shall be horizontal with minimum dimensions 400 x 500 mm;
- c) the floor shall be manufactured from slip-resistant material. The design shall provide means to eliminate the retention of liquid and debris;
- d) precautions shall be taken to prevent the operator from falling from the platform. This shall be in accordance with prEN 13586:1999.

5.8.2.4 Access and egress to raised control stations

The means of access to raised control stations shall fulfil the following requirements:

- a) provision shall be made for a simultaneous three-point support (two hands and one foot or two feet and one hand);
- b) safe exit for all service configurations of the crane shall be provided;
- c) hand rails and hand holds shall not have sharp edges and preferably be of circular section;
- d) steps and all surfaces shall be slip resistant at the foot contact area. Round steps shall not be used;

NOTE Annex L gives examples of acceptable profiles.

- e) ladders steps shall be of minimum width 300 mm (see annex L, table L.2); A footstep of 150 mm width is only acceptable where space restrictions do not permit 300 mm width;
- f) the angle of ladders shall be 75 to 90 degrees above the horizontal.

For dimensional data see informative annex L and prEN 13586:1999.

5.9 Electrical systems and related phenomena

5.9.1 General

 The electrical equipment of loader cranes shall, where appropriate, comply with EN 60204-32:1998 .

5.9.2 Electromagnetic compatibility

For immunity the electrical system shall conform to EN 50082-2:1995.

For emission the electrical system shall conform to EN 50081-2:1993.

When the manufacturer of the crane uses certified components for the electrical system which fulfil the requirements of the above mentioned standards and install these components in accordance with the recommendations of the supplier, testing of the electromagnetic compatibility of the complete electrical system is not necessary.

5.10 Installation

5.10.1 General

Loader cranes can be installed on various types of mountings.

A loader crane cannot normally be operated and does not become a complete machine until it has been installed onto its working position and connected to a power supply by the installer.

5.10.2 Mounting

5.10.2.1 Vehicle mounting

The installer of a loader crane shall adhere to any specific requirements issued by the crane manufacturer, the vehicle manufacturer, local regulations which may apply, and any site conditions (for static installations). The mounting frame shall be constructed and secured to the vehicle frame so that it can withstand the imposed loads and meet the requirements of chassis strength specified by the vehicle manufacturer.

NOTE Annex M shows the calculation method for determination of mounting frame size.

The loader crane shall be positioned on the chassis to ensure that the completed installation meets the road regulations for maximum permissible axle capacities, vehicle width, height and the stability requirements of 5.10.3.

5.10.2.2 Static mounting

The foundation shall be constructed so that it can withstand the imposed loads and provide positive securement for the crane fastenings at the mounting points; the size of the foundation shall not inhibit the normal crane movements. The dimensions of the foundation in the ground shall consider the total imposed loads and the relevant ground conditions.

5.10.2.3 Location

The location of the ground control stations and any additional control stations which may be required shall also be considered when determining the crane position. Control stations shall be positioned:

- a) to ensure that operators are not exposed to inhalation of exhaust gases;
- b) to ensure that operators cannot touch hot surfaces during normal crane operations. Any surfaces with temperatures exceeding 55 °C shall be protected;
- c) to minimize the risk of crushing or trapping the operator by movements of any of the loader crane or stabilizer functions. Guards shall be fitted as necessary to protect/prevent the operator from being crushed/trapped in any confined areas between the crane and the vehicle.

Danger zones caused by moving parts of the stabilizers and its drives shall be protected by guards/safety measures.

Examples of stabilizer danger zones are:

- entanglement zones at pulleys/bogie wheels;
- shearing zones at openings in the moving part of the stabilizer extension;
- entanglement zones at chains/cables of the stabilizer extension;

A₂ The safety distances of EN 294:1992, EN 349:1993 and EN 811:1996 shall apply with the following exceptions: For the areas of chassis, stabilizers and moving counterweight, where neither safe clearance in accordance with EN 349 nor guarding according to EN 294:1992 or EN 811:1996 is possible, warning notices shall be fitted. However, control stations shall be placed so that the use of the controls does not require the operator to reach into danger zones, where risk of shearing and trapping exists. **A₂**

Hydraulic hoses containing fluid with a pressure of more than 5Mpa and/or having a temperature over 50°C and which are located within 1,0 m of the operator shall be guarded.

5.10.3 Stability

The stability for a loader crane installed on a vehicle shall be such that the working unit does not overturn under foreseen operating conditions. Verification of the stability shall be made by test loading according to 6.2.5.

When determining the position of the crane for installation according to 5.10.2 the stability (for guidance) may be deduced by calculation using the formula shown in 6.2.5.3.

5.10.4 Noise

With regard to noise hazards, the case where the power source is an integral part of the crane is not dealt with in the present edition of this standard. It will be dealt with in an amendment.

5.10.5 Vibrations

A loader crane is generally only used for short periods of time and the effect of vibrations on the operator is regarded to be not significant.