BS EN 14985:2012

BSI Standards Publication

Cranes — Slewing jib cranes

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National foreword

This British Standard is the UK implementation of EN 14985:2012. It supersedes BS EN 14985:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MHE/3/3, Bridge, gantry and slewing jib cranes.

A list of organizations represented on this committee 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.

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This European Standard was approved by CEN on 9 December 2011.

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-CENELEC Management Centre or to any CEN member.

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Foreword

This document (EN 14985:2012) 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of an identical text or by endorsement, at the latest by August 2012, and conflicting national standards shall be withdrawn at the latest by August 2012.

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

This document supersedes EN 14985:2007.

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.

This revision does not contain any fundamental changes. However, a number of clauses have been redrafted for reasons of clarity and technical and editorial accuracy.

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

Introduction

This European Standard has been prepared to be a harmonised standard to provide one means for slewing jib cranes to conform with the essential health and safety requirements of the Machinery Directive, as mentioned in Annex ZA.

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

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

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.

1 Scope

This European Standard applies to electrically or hydraulically powered slewing jib cranes mounted in one position or free to travel on horizontal rails. It does not apply to wall mounted, pillar, derrick, railway, tower or workshop jib cranes. This European Standard is not applicable to erection, dismantling operations, or changing the configuration of the crane.

This European Standard gives requirements for all significant hazards, hazardous situations and events relevant to slewing jib cranes, when used as intended and under conditions foreseen by the manufacturer (see Clause 4).

The specific hazards due to potentially explosive atmospheres, ionising radiation, and operation in electromagnetic fields beyond the range of EN 61000-6-2 are not covered by this European Standard.

This European Standard does not include requirements for the lifting of persons.

This European Standard is applicable to slewing jib cranes, which are manufactured after the date of approval by CEN of this European Standard.

2 Normative references

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

EN 547-1, *Safety of machinery — Human body measurements — Part 1: Principles for determining the dimensions required for openings for whole body access into machinery*

EN 547-2, *Safety of machinery — Human body measurements — Part 2: Principles for determining the dimensions required for access openings*

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

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

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

EN 12077-2:1998+A1:2008, *Cranes safety — Requirements for health and safety — Part 2: Limiting and indicating devices*

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

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

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

EN 13001-2:2011, *Crane safety — General design — Part 2: Load actions*

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

CEN/TS 13001-3-2, *Cranes — General design — Part 3-2: Limit states and proof of competence of wire ropes in reeving systems*

EN 13135-1, *Cranes — Equipment — Part 1: Electrotechnical equipment*

EN 13135-2, *Cranes — Equipment — Part 2: Non-electrotechnical equipment*

EN 13155, *Cranes — Safety — Non-fixed load lifting attachments*

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

EN 13586, *Cranes — Access*

EN 60204-11, *Safety of machinery — Electrical equipment of machines — Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV (IEC 60204-11)*

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

EN 60825-1, *Safety of laser products — Part 1: Equipment classification and requirements (IEC 60825-1)*

EN ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871)*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections (ISO 11201:2010)*

EN ISO 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1)*

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

EN ISO 13732-1:2008, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1:2006)*

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

EN ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857)*

ISO 3864 (all parts), *Graphical symbols — Safety colours and safety signs*

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

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

ISO 7752-4, *Cranes — Controls — Layout and characteristics — Part 4: Jib cranes*

ISO 8566-4, *Cranes — Cabins — Part 4: Jib cranes*

ISO 9374-4, *Cranes — Information to be provided — Part 4: Jib cranes*

ISO 12210-4, *Cranes — Anchoring devices for in-service and out-of-service conditions — Part 4: Jib cranes*

ISO 12488-4, *Cranes — Tolerances for wheels and travel and traversing tracks — Part 4: Jib cranes*

FEM 1.001:1998, booklets 9 and 10, *Rules for the design of hoisting appliances*

3 Terms and definitions

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

3.1
rated capacity
m_{RC}
maximum net load (the sum of the payload and non-fixed load-lifting attachment) that the crane is designed to lift for a given crane configuration and load location during normal operation

3.2
hoist load
m_H
sum of the masses of the load equal to the rated capacity, the fixed lifting attachment and the hoist medium

3.3
slewing jib crane
power operated crane designed for permanent installation, mounted in either a fixed position or free to travel on horizontal rails, equipped with a jib which is able to rotate around a vertical axis

3.4
direct acting lifting force limiter
device that limits the force on the system to a specified level

3.5
indirect acting force limiter
device that measures the force on the system and activates a second device to stop the motion

4 List of hazards

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

Table 1 — List of significant hazards and associated requirements

No.	Hazard	Relevant clause(s) in this European Standard
1	**Mechanical hazards**	
1.1	Generated by machine parts or workpieces, e.g. by:	
1.1.1	Shape	
1.1.2	Relative location	5.7.2
1.1.3	Mass and stability	5.2
1.1.4	Mass and velocity	5.4.4, 5.4.5,
1.1.5	Inadequacy of mechanical strength	5.2
1.2	Accumulation of energy inside the machinery, e.g. by:	
1.2.1	Elastic elements (springs)	
1.3	Elementary forms of mechanical hazards	
1.3.1	Crushing	5.1, 5.7.2, 7.2
1.3.2	Shearing	5.7.2
1.3.3	Cutting or severing	
1.3.4	Entanglement hazard	
1.3.5	Drawing-in or trapping hazard - moving transmission parts	5.7.2
1.3.6	Impact	5.5.3, 7.2
1.3.7	Stabbing or puncture hazard	
1.3.8	Friction or abrasion hazard	
2	**Electrical hazards** due to:	5.3
2.1	Contact of persons with live parts (direct contact)	5.3.6.1
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	5.3.6.2
2.3	Approach to live parts under high voltage	5.3.5.
2.4	Electrostatic phenomena	7.4
3	**Thermal hazards,** resulting in:	
3.1	Burns and scalds, by possible contact of persons with objects or materials with an extreme temperature, by flames, by radiation, etc.	5.6.1, 7.5
4	**Hazards generated by noise,** resulting in:	
4.1	Hearing losses	5.7.4, 7.3
4.2	Interference with speech communication, signals, etc.	5.7.4, 7.3
6	**Radiation**	
6.0	External radiation	See Introduction
6.1	Low frequency, radio frequency radiation, micro waves	5.6.2
6.2	Infrared, visible, UV-light	
6.3	X and gamma rays	
6.4	Alpha, beta rays, electron or ion beams; neutrons	
6.5	Lasers	5.6.3
7	**Processed materials and substances, used materials, fuels**	

7.1	Hazards from contact with harmful fluids, gases, mists, fumes and dusts	5.6.4, 5.6.5, 5.6.6 See Introduction
7.2	Fire or explosion hazard	See Introduction
8	**Neglected ergonomic principles in machine design,** e.g. hazards from:	
8.1	Unhealthy postures or excessive efforts	5.7.1.2
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	
8.3	Neglected use of personal protection equipment	7.3
8.4	Inadequate local lighting	5.7.3
8.5	Mental overload or underload, stress	7.3
8.7	Inadequate design, location or identification of manual controls	5.7.1
8.8	Inadequate design or location of visual display units	5.8.2
10	**Unexpected start-up, unexpected overrun/over-speed** (or any similar malfunction) from:	5.3, 5.5
10.1	Failure/ disorder of control systems	5.7.1
10.3	External influences on electrical equipment	5.3.2
10.4	Other external influences (gravity, wind, etc.)	5.4.2.2, 5.4.4.1, 5.4.5.1/2
10.5	Errors in the software	5.3.9
10.6	Errors made by the operator (due to mismatch of machinery with human characteristics and abilities)	7.2
11	**Impossibility of stopping the machine in the best possible conditions**	5.4.5.1
13	**Failure of the power supply**	5.4.2
16	**Break-up during operation**	5.2, 7.4, 7.5
17	**Falling or ejected objects or fluid**	5.7.2
19	**Slip, trip and falling of persons** (related to machinery)	5.7.2
Additional hazards and hazardous events due to mobility		
20	**Relating to the travelling function**	
20.1	Uncontrolled movement of crane when starting the engine	5.3.8
20.2	Movement without a driver at the driving position	5.3.8
20.3	Movement without all parts in a safe position	5.3.8
20.4	Excessive speed of pedestrian controlled machinery	
20.5	Excessive oscillations when moving	5.2.8.6
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilised	5.4.5.1, 7.3
21	**Linked to the work position** (including driving station) on the machine	
21.1	Fall of persons during access to (or at/from) the work position	5.7.2

21.2	Exhaust gases / lack of oxygen at the work position	5.6.5
21.3	Fire (flammability of the cab, lack of extinguishing means)	5.6.4
21.4	Mechanical hazards at the work position: - Contact with the wheels - Fall of objects, penetration by objects - Contact of persons with machine parts or tools (ped. contr.)	5.7.2
21.5	Insufficient visibility from the working position	5.7.1.3, 5.7.3, 5.8.2
21.6	Inadequate lighting	5.7.3
21.7	Inadequate seating	5.7.1.3
21.8	Noise at the driving position	5.7.4, 7.3
21.9	Vibration at the driving position	5.2.8.6
21.10	Insufficient means of evacuation/emergency exit	5.6.4
22	**Due to the control system**	
22.1	Inadequate location of controls /control devices	5.3.9.1, 5.7.1.1
22.2	Inadequate design of the actuation mode and/or action mode of controls	5.7.1.1
25	**From/to third persons**	
25.1	Unauthorised start-up/use	5.4.2
25.2	Drift of a part away from its stopping position	5.4.6.2
25.3	Lack or inadequacy of visual or acoustic warning means	5.8
26	**Insufficient instructions for the driver / operator**	
26.1	Movement into prohibited area	7.3
26.2	Tipping - Swinging	7.2, 7.3
26.3	Collision: machines-machines	7.3
26.4	Collision: machines-men	7.3
26.5	Ground conditions	
26.6	Supporting conditions	7.3
27	**Mechanical hazards and events**	
27.1	From load falls, collision, machine tipping caused by:	
27.1.1	Lack of stability	5.2.1
27.1.2	Uncontrolled loading - overloading – overturning moment exceeded	5.5.2
27.1.3	Uncontrolled amplitude of movements	7.2
27.1.4	Unexpected/unintended movement of loads	7.2, 7.3
27.1.5	Inadequate holding devices / accessories	7.2
27.1.6	Collision of more than one machine	7.3
27.1.7	Two-block of hook to hoist	5.5.1.3.1
27.2	From access of persons to load support	7.2
27.3	From derailment	
27.4	From insufficient mechanical strength of parts	5.2, 5.4.7
	Loss of mechanical strength, or inadequate mechanical strength	5.2, 7.4
27.5	From inadequate design of pulleys, drums	

27.6	From inadequate selection/ integration into the machine of chains, ropes, lifting accessories	5.4.4
27.7	From lowering of the load by friction brake	5.4.2.3, 7.2
27.8	From abnormal conditions of assembly/ testing/ use/ maintenance	7.1
28	**Electrical hazard**	
28.1	From lightning	7.4
34	**Mechanical hazards and hazardous events** due to:	
34.1	Inadequate working coefficients	5.2, 5.5
34.2	Failing of load control	5.4.2.3

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 for relevant but not significant hazards, which are not dealt with by this European Standard.

5.2 Requirements for strength and stability

5.2.1 Selection of classification parameters

Service parameters shall be selected in accordance with EN 13001-1 and used as the basis of design.

NOTE Guidance on the selection of classification parameters is given in Annex A.

5.2.2 Selection of loads and load combinations

The basic load combinations for the load calculation shall be selected in accordance with EN 13001-2, using the descriptions given in Annex B of this standard.

The recurrence period according to EN 13001-2 for out of service wind shall be minimum 25 years.

5.2.3 Determination of factor ϕ_2

The factor ϕ_2 shall be determined according to the principles of EN 13001-2:2011.

When experiments or analysis are used without reference to a hoisting class, the hoist speed applied shall be as specified for the particular HD-class of EN 13001-2:2011. Analysis shall cover all the dynamic and elastic properties of the crane, including the hoist mechanism and the behaviour of the drive system.

Alternatively a slewing jib crane may be assigned to one of the hoisting classes HC1 to HC4 of EN 13001-2:2011. The class is dependent upon the vertical hoist load displacement δ. This hoist load m_H being applied statically at the point of suspension and the resultant displacement δ takes account of the elasticity within the cranes own structure and that of the rope system. The resultant HC class shall be determined as per Table 2.

Table 2 — Hoisting class selection

Vertical load displacement δ	Hoisting class
1,6 m $\leq \delta$	HC1
0,55 m $\leq \delta$ < 1,6 m	HC2
0,20 m $\leq \delta$ < 0,55 m	HC3
δ < 0,20 m	HC4

The load displacement δ shall be calculated using the appropriate maximum hoist load value without amplifying factors.

The load displacement may vary for differing load/radius combinations and so result in different hoisting classes. Account shall be taken of these variances in the design calculations.

5.2.4 Stall load condition

5.2.4.1 Cranes with direct acting lifting force limiter

The maximum force, F_{DAL}, which is applied to the crane when the direct acting lifting force limiter operates, shall be calculated as follows:

$$F_{DAL} = \phi_{DAL} \cdot m_H \cdot g$$

where

ϕ_{DAL} is the factor for the limit load setting;

m_H is the mass of the hoist load;

g is the acceleration due to gravity.

For hydraulic systems, the factor ϕ_{DAL} shall be less than, or equal to 1,4.

The force F_{DAL} shall be assigned to the load combination C1 of Table 10 in EN 13001-2:2011 and as a load to line 13 in the stability combination C3 of Table 11 in the same standard.

5.2.4.2 Cranes with indirect acting lifting force limiter

The maximum force, F_{IAL}, which is applied to the crane, resulting from the operation of the indirect acting lifting force limiter, shall be calculated as follows:

$$F_{IAL} = \phi_{IAL} \cdot m_H \cdot g$$

where

ϕ_{IAL} is the load factor for the stall load condition;

m_H is the mass of the hoist load;

g is the acceleration due to gravity.

NOTE 1 The F_{IAL} represents the final load in the hoist system after the triggering has operated and the hoist motion is brought to rest.

NOTE 2 Annex C indicates a method of calculation for the factor ϕ_{IAL}, as a function of specified crane and hoist parameters.

The force F_{IAL} shall be assigned to the load combination C1 of Table 10 in EN 13001-2:2011 and as a load to line 13 in the stability combination C3 of Table 11 in the same standard.

5.2.5 Loads caused by acceleration

For all crane drive motions, the change in load effects, ΔS, caused by acceleration shall be calculated according to the following equation:

$$\Delta S = S_{(f)} - S_{(i)}$$

where

$S_{(f)}$ is the final load effect;

S(i) is the initial load effect.

NOTE The change in load effects, ΔS, is caused by the change of drive force, ΔF, given by the equation:

$$\Delta F = F(f) - F(i)$$

where

F(f) is the final drive force and

F(i) is the initial drive force.

The change in load effects, ΔS, shall be multiplied by a factor ϕ_5 and algebraically added to the initial load effect, $S_{(i)}$, present before the change of drive forces (see EN 13001-2:2011). The resulting load actions shall be calculated according to EN 13001-2.

For cranes without level luffing, account shall be taken of acceleration forces caused by operation of the luffing motion.

5.2.6 Jib side loading

Design features which induce side loading on jibs shall be included with all applicable load combinations for which calculations are performed, combined so as to maximise side loading.

NOTE In addition to slewing and wind effects, an example of a feature affecting side loading would be a reeving arrangement that causes the hoist line to deviate from the jib centreline.

5.2.7 Test loads

The overload test load to be taken into account in calculation shall be as given in 6.2.

5.2.8 Conditions of use of permissible stress method and limit state method

5.2.8.1 General

Selection of allowable stress method or limit state method shall be made according to EN 13001-1 and EN 13001-2.

5.2.8.2 Limit states and proof of competence of structural members

The limit states and proof of competence of structural members and connections shall be determined according to CEN/TS 13001-3-1.

5.2.8.3 Limit states of mechanical components

Verification of ropes shall be in accordance with CEN/TS 13001-3-2.

An EN standard for the verification of rail wheels is under preparation. While the appropriate standard is not available, the rail wheels and rails shall be verified according to FEM 1.001:1998, 10.01, 4.2.4 as amended in booklet 9, 9.12.

5.2.8.4 Proof of strength of lifting points

Lifting points (holes and lugs) used for erection and maintenance purposes shall be calculated by either:

— using theory of plasticity with a minimum factor of 4 and welds to structures with a minimum factor of 5 against ultimate strength of steel; to justify the use of this theory, the elongation A5 according to EN ISO 6892-1 of the materials shall be at least 15 %, or

— using the theory of elasticity.

5.2.8.5 Elastic deformation

The elastic deformations of the crane structure shall not have a detrimental influence on the functioning of the crane.

5.2.8.6 Vibration frequencies

To avoid uncomfortable vibrations for the operator in the cabin the natural frequency of the structure supporting the cabin shall not be less than 2 Hz.

5.2.9 Stability of rail mounted cranes

5.2.9.1 General requirements

Proof of stability of the crane shall be according to principles and load combinations of EN 13001-2.

A slewing jib crane is considered to be stable, if the overturning moment is smaller than the stabilising moment about any tipping axis.

Basic crane configuration is assuming a rail-mounted crane standing on four or more corners and with all legs rigid.

5.2.9.2 Special crane configurations

An additional risk coefficient γ_n shall be applied for all non-favourable loads of Table 11 in EN 13001-2:2011 based upon the leg and portal configuration of the crane as follows:

— A. cranes standing on three corners: $\gamma_n = 1,10$

— B. cranes with a hinged leg in one or more of the corners:

— hinged leg corner lifting up: $\gamma_n = 1,10$

— fixed leg corner lifting up: $\gamma_n = 1,22$

5.2.9.3 Design of tie-downs

If the stability of the crane does not meet the requirements of EN 13001-2 for storm wind conditions, it shall be equipped with tie-downs designed with the partial load factors according to that same standard. Additionally, when relevant, the risk coefficients according to 5.2.9.2 shall be applied in assessing the loads on the crane.

The material resistance factors γ_m for design of tie-downs and their fastening points shall be taken as follows:

— for steel sections $\gamma_m = 1{,}34$;

— for wire ropes and chains $\gamma_m = 2{,}50$.

5.3 Electrotechnical equipment

5.3.1 General

The electrical installation and equipment shall comply with EN 60204-32:2008, as amended by the subclauses of this clause.

5.3.2 Physical environment and operating conditions

The electrical equipment shall be suitable for use in the physical environment and operating conditions specified in 4.4 of EN 60204-32:2008.

When the physical environment or the operating conditions are outside those specified above the specification of the electrical equipment shall be amended accordingly. Attention should be given to wind chill effects and solar heat gain.

5.3.3 Electrical supply

The electrical equipment shall be designed to operate in accordance with the provisions of 4.3 of EN 60204-32:2008.

High voltage equipment (exceeding 1 kV AC or 1,5 kV DC) shall comply with EN 60204-11. All references to EN 60204-1 in EN 60204-11 shall be considered as references to the respective clauses in EN 60204-32:2008.

Where a collector system is used for the incoming supply and it cannot be totally enclosed to prevent danger to personnel and damage by the operation of the crane or associated activities, the provisions of 12.7.1 of EN 60204-32:2008 shall apply.

NOTE Where reasonably practicable a crane should be connected to a single power supply. Exceptions being very large cranes or cranes with on board generators where a secondary supply, usually of a limited capacity, may be provided for maintenance, limited operational applications (e.g. positioning or standby heating).

All conductors shall be clearly identifiable at each termination in accordance with 13.2 in EN 60204-32:2008.

Additional provisions as specified in 5.1 of EN 60204-32:2008 shall apply.

5.3.4 External protective earthing and equipotential bonding

Each incoming supply shall include a protective earthing conductor, which shall be connected to the crane rails, crane structure and the electrical equipment in accordance with the provisions of Clause 8 of EN 60204-32:2008.

5.3.5 Supply disconnecting and switching off

The supply disconnection and switching off functions shall be performed by the following devices:

— crane-supply-switch;

— crane-disconnector;

— crane-switch.

These devices shall conform to 5.3 of EN 60204-32:2008. The crane supply switch shall be capable of being locked in the off position.

Where it is necessary to work on individual parts of the electrical equipment of a crane, additional disconnecting devices shall be provided for each part requiring separate isolation. Such devices shall comply with 5.4 to 5.6 of EN 60204-32:2008.

5.3.6 Protection against electric shock

5.3.6.1 Protection against electric shock by direct contact

Protection against electric shock by direct contact shall comply with EN 60204-32:2008, 6.2 as amended below.

Protection by barriers is only acceptable in areas restricted to skilled personnel undertaking maintenance work.

Protection by placing out of reach shall not be used.

5.3.6.2 Protection against electric shock by indirect contact

Protection against electric shock by indirect contact shall comply with EN 60204-32:2008, 6.3 or 6.4 as amended below.

Protection by electrical separation shall not be used.

5.3.7 Conductors and cables

5.3.7.1 General

Conductors and cables shall be suitable for the operating conditions and external influences that can exist and be installed so as to avoid mechanical damage or be suitably protected. They shall comply with 12.1 to 12.6 of EN 60204-32:2008.

5.3.7.2 Collector wires, collector bars and slip-ring assemblies

Collector wires, collector bars and slip-ring assemblies shall, where practicable, be totally enclosed so as to prevent danger to personnel and damage by the operation of the crane or associated activities. Where this cannot be achieved the provisions of 12.7.1 of EN 60204-32:2008 shall apply. In addition they shall also comply with the provisions of 12.7.2 to 13.7.8 of EN 60204-32:2008.

5.3.7.3 Wiring practice

Wiring practices shall comply with Clause 14 of EN 60204-32:2008.

5.3.8 Control circuits and control functions

5.3.8.1 General

The provisions of Clause 9 of EN 60204-32:2008 shall apply as amended by 5.3.8.2 and 5.3.8.3 of this European Standard.

All safety-related parts of control systems shall fulfill at least Performance Level c of EN ISO 13849-1:2008.

Control circuits built with electromechanical, hydraulic and pneumatic components shall fulfill at least Performance Level c and category 1.

NOTE 1 The requirement to have at least category 1 excludes a structure of Category B.

Control circuits built with electronic or programmable components, respectively, shall fulfill at least Performance Level c and category 2.

NOTE 2 The requirement to have at least category 2 excludes a structure of Category B or 1.

STOP function in cable-less control systems, as laid down in C.3.1 of EN 13557:2003+A2:2008, shall fulfill at least Performance Level c and category 3.

In high risk applications, as specified EN 13135-2, a hazard assessment shall be undertaken to establish the higher performance level requirement.

5.3.8.2 Suspension of safeguarding

Operation of the device for suspending safeguarding shall be limited by placing the device inside an enclosure access to which requires special tools or by other suitable means.

5.3.8.3 Combined start and stop controls

Combined start and stop controls as specified in 9.2.6.4 of EN 60204-32:2008 shall not be used for motion drives.

5.3.9 Operator interface and mounted control devices

5.3.9.1 General

Mounted control devices shall comply with the provisions of Clause 10 of EN 60204-32:2008 and 5.3.9.2 to 5.3.9.4 below.

5.3.9.2 Push-buttons

Push buttons shall be colour coded as shown below.

— Start/On	Green
— Stop/Off	Black
— Hold to Run	White
— Reset	Blue
— Emergency Stop and other emergency functions	Red

Push buttons for other functions shall be coloured either yellow or grey.

NOTE The stop actuator of a cable less control station may be red.

Start/On, Stop/Off and Hold to Run buttons shall be marked in accordance with the provisions of 10.2.2 of EN 60204-32:2008, and the function to be activated shall be indicated on or near to the button.

5.3.9.3 Indicator lights

Indicator lights shall be coloured as shown in Table 4 of 10.3.2 of EN 60204-32:2008.

5.3.9.4 Emergency stop

An emergency stop device to stop all drive motions shall be provided at each control station. Devices shall also be provided in the following locations to stop the appropriate motions:

- close to the access point to the slewing part,
- at ground level on both sides or at each corner of the portal depending on portal size,
- in the machinery room and
- next to each major machinery located outside the machinery room.

Emergency stop devices located at control stations shall be of the mushroom-headed push-button self-latching type. The emergency stop devices for other locations shall be located so as to achieve easy identification and access to them, and to avoid unintentional actuation.

Emergency stop devices shall actuate a category 0 stop in accordance with EN 60204-32:2008, unless a hazard assessment establishes that a category 1 stop is more appropriate.

NOTE With regard to 9.2.2 of EN 60204-32:2008, certain control systems (e.g. for converters) may have a short time delay before the power supply is removed, for ensuring that no additional hazard occurs.

5.3.10 Control gear – Location, mounting and enclosures

Control gear shall conform to EN 60204-32:2008, Clause 11.

5.3.11 Electrical requirements for the installation of load handling devices

The relevant provisions of EN 13155 shall apply.

The provision of Clauses 12 and 13 of EN 60204-32:2008 shall apply.

Electric cables to load lifting attachments shall be installed and protected in such a way that damage is avoided during normal operation.

Battery-supplied load holding magnets and load holding magnets with back up batteries shall be equipped with an automatic warning device indicating clearly the state of charge of the battery and when the crane operation has to stop so as to avoid the unintentional release of the load.

5.3.12 Electric motors

Electric motors shall conform to EN 13135-1.

All motions shall be power driven at all times.

5.4 Non-electrotechnical equipment

5.4.1 General

The mechanical and hydraulic equipment shall meet the requirements of EN 13135-2 as amended by this European Standard.

5.4.2 Braking systems

5.4.2.1 General

All motions shall be under the control of a braking system at all times. The braking systems shall be such that movements can be decelerated, the motions can be held and unintentional movements avoided. The systems shall be capable of bringing a fully loaded crane to rest, without excessive shock, from the highest speed it can attain.

Brakes shall engage automatically in the following cases:

— the control device returns to its neutral position;

— the power supply to the brake is interrupted;

— the emergency stop device is activated;

— the power supply of the associated drive motor is interrupted or switched off.

NOTE In a hydraulic system, this requirement is fulfilled, for example, by devices which prevent the motion from moving.

5.4.2.2 Service brakes

Only power release brakes shall be used and they shall maintain their ability to stop the motion, at all times, taking into account:

— the number of braking operations in a given period based on crane duty and type of operation;

— the type of drive control;

— the braking after interruption of power or emergency stop (see EN 60204-32);

— the kinetic energy of all rotating parts;

— the kinetic energy of linearly moving masses;

— the difference of potential energy of the lowered masses during braking;

— the load for dynamic tests;

— the action of maximum in-service wind from any direction.

With spring-loaded brakes, brake springs shall be compression springs and shall be guided. The coils of helical springs shall not be able to intertwine in the event of a wire break.

If the braking force is applied by pre-stressed springs, the failure of any spring in the braking system shall not reduce the available torque by more than 20 %.

If less than 5 springs are used, they shall be dimensioned such that the wire diameter is greater than half the coil pitch in the working condition to prevent screwing in of the two spring parts in the event of a wire break.

Brake linings shall be made of asbestos free material.

It shall be possible to check the wear of the brake lining(s) and to re-adjust the brake without the need to dismantle the unit.

Braking devices shall be such that the user cannot adjust the design specific braking effort without the need of a tool.

The connection between the brake lining and the brake lining holder shall prevent unintentional release.

Brakes shall be protected from the ingress of substances within the environment, which are likely to have a detrimental effect on the performance of the brake.

5.4.2.3 Brakes for hoisting and luffing jib movements

The brakes shall be designed to exert a restraining torque of at least 60 % greater than the maximum torque transmitted to the brake from the maximum suspended load under service conditions. The reaction time of the braking shall be such that it does not allow the load to accelerate to a lowering speed greater than 1,3 times the rated lowering speed.

NOTE The specified speed limit 130 % is the final speed resulting from the triggering and braking sequence, considering all the response delays in the system. Typically the overspeed triggering needs to be set to operate at approximately 110 % speed.

The brakes for hoisting shall have a manual release facility, which allows the load to be brought to a safe position in a controlled manner or can be used to prevent tightening of hoist ropes in case of a jammed load. This release facility shall be such that it can only be operated by special equipment or tools, which require active operation at all times. The instruction handbook shall provide information on the safe use of such equipment. See also 7.2.

A manual release facility of brakes shall not be provided for luffing jib movement.

5.4.3 Hoisting mechanism

5.4.3.1 Dual hoist mechanism

When dimensioning the load bearing and powering of each mechanism, the distribution of the load to each mechanism shall be taken into account, as well as the frequent, continuous and transient load distribution cases, which are dependent upon the mechanical configuration and the control system.

The brakes of each mechanism shall hold at least 125 % of the lowering torque of the total load.

5.4.3.2 Speed change gear

Where speed change gears are used, (e.g. separate speed change gear reducer or speed change gears built in the main gear enclosure) there shall be a brake or mechanical locking means between the speed change gear and the hoist rope, capable of holding the weight of the lifting attachments while the gear is switched from one speed to another.

The speed change system shall only allow the speed to be changed under no-load conditions and when brakes or mechanical locking means have been engaged so that the load lifting attachments cannot descend. The speed change system shall also interlock the hoisting drive such that it cannot be energized.

When the speed change is made by moving a pair of gear wheels axially or by a coupling device, provision shall be made to prevent engagement of the hoist motor in an intermediate gear position.

5.4.4 Luffing system

5.4.4.1 Mechanism

With rope/chain reeving or rack and pinion systems the mechanism shall include a dual luffing element system according to 5.4.4.2, if:

— the dead weight moment of the jib on one side of the pivot is not balanced by a counterweight moment on the other side within ± 10 %; or

— the height difference of the highest and lowest point of the load path is more than 3 % of the length of the luffing range.

5.4.4.2 Dual luffing elements

The luffing element shall when duplicated (see 5.4.4.1), satisfy the following principles:

— either element shall be capable of holding the jib and load in the event of an element failure. Loads resulting from this type of failure shall be assigned to load combinations C in EN 13001-2;

— a means shall be provided to equalise the loads between the luffing elements; this may be based upon an electrical system or mechanical or hydraulic balancing.

5.4.4.3 Brakes for dual luffing elements

With a dual luffing element system (see 5.4.4.1) the luffing mechanism shall be equipped with either a service and backup brake or two similar service brakes. Each brake alone shall be capable of arresting the motion's energy from any operational speed and permissible loading, then hold the jib and load at rest. One service brake may be used only when there is a single drive system for the luffing motion and the luffing elements are mechanically connected together.

In case the dual luffing elements are individually driven, each drive mechanism shall have a service brake with a minimum service factor of:

— 1,5 for mechanically connected mechanisms;

— 2,0 for mechanically independent mechanisms.

The mechanical connection between mechanisms shall be capable of transferring all the loads arising in any loading condition.

5.4.5 Slew mechanism

5.4.5.1 Parking in out-of-service condition

In out-of-service conditions the slewing mechanism shall be locked. The forces due to the torque from the slewing structure in the maximum out-of-service wind conditions shall be carried either by brakes or by a mechanical locking device. However, the performance shall not rely upon the combination of the two.

The parking system shall meet the requirements of EN 13001-2:2011 (Table 10, γ_p = 1,16 for storm wind and γ_m = 1,1 for brakes or locking).

5.4.5.2 Slew bearing

The structure mounting support for the slew bearing shall be of adequate strength and stiffness, level and flat, and present a smooth surface for the bearing. The bearing and its fixing bolts shall be able to withstand the maximum loading associated with load combinations A, B and C of Annex B.

For the proof of competence of the slew bearing lifetime, the following shall be taken into account:

a) Loading conditions for the calculation shall include:

   1) each load/radius combination of the crane, with the number of work cycles specific for the work tasks carried out by the crane;

   2) unloaded, return part of the work tasks;

   3) slewing sectors specific for the work tasks carried out by the crane;

4) load combinations A of EN 13001-2:2011 with the partial safety factors and dynamic coefficients set to 1.

b) Result of the lifetime calculation shall be expressed as a number of crane work cycles, and this shall be not less than the total number of working cycles specified for the crane according to EN 13001-1.

5.4.6 Travel mechanism

5.4.6.1 Friction drive capacity

The travel drive and braking systems shall be designed so that they are capable of controlling and stopping the movements with maximum specified slope and maximum operational wind speed for any load - wind area combinations within the specified limits.

When evaluating the accelerations and decelerations, the friction coefficient between the rail and the wheel shall not be taken greater than 0,14 for steel wheel on steel rail.

Travel motions shall be provided with brakes capable of stopping the crane in the maximum in-service tail wind in a distance not more than 1,5 times the power controlled distance without wind.

5.4.6.2 Anchoring in out-of-service wind conditions

If the minimum foreseeable friction or the braking torque of the braked wheels cannot prevent the crane or trolley from drifting away in the specified out-of-service wind conditions according to EN 13001-2 the crane shall be equipped with:

— rail clamps that can operate at any position of the track; or

— anchor pins or other means of same function that can hold the crane in certain anchoring positions, in accordance with ISO 12210-4; these devices shall be mounted on the crane in such away that there is no risk of the device becoming disengaged.

5.4.6.3 Bogies, wheels and tracks

5.4.6.3.1 Wheels and track tolerances shall be in accordance with ISO 12488-4.

5.4.6.3.2 The bogie arrangement shall be such that no more than one bogie need be removed when a wheel or one of its components is removed for repair or replacement. Jacking points shall be included and shall be marked and shown in the maintenance manual.

5.4.7 Gear drives

The equipment shall be in accordance with EN 13135-2 and in addition the further requirements noted within this subclause.

Gear drives shall be dimensioned according to the mechanisms classification/loading requirements selected by referencing EN 13001-1 and EN 13001-2 for the motion under consideration.

The sizing of gearing to meet the strength and durability requirements shall be calculated according to ISO 6336-1 and ISO 6336-2.

5.5 Limiting and indicating devices

5.5.1 Rated capacity limiters

5.5.1.1 General

Cranes with a rated capacity of 1 000 kg or above, or an overturning moment of 40 000 Nm or above due to the load shall be fitted with a rated capacity limiter complying with 5.3 and 5.4 of EN 12077-2:1998+A1:2008 to control both the hoisting and luffing mechanisms and if need be the slewing mechanism.

5.5.1.2 Operation

The rated capacity limiter shall override the controls of the crane when the load on the crane exceeds the rated capacity so as to prevent any condition that will increase the loading of the crane beyond the design limits.

NOTE Rated capacity limiters act by limiting the force flow (direct acting limiters) or by measuring the load using a sensor and overriding the controls to prevent excessive loading by bringing the motion to rest (indirect force limitation).

Direct acting force limiters based on friction shall not be used.

Lifting force limiters shall provide overload protection and stall load protection as described in 5.5.1.3. and 5.5.1.4.

5.5.1.3 Overload protection

5.5.1.3.1 Hoisting

The setting of the rated capacity limiter shall be such that a load exceeding the maximum hoist load – specific for each load/radius - multiplied by the triggering-factor α shall trigger the limiter. The triggering-factor shall be $\leq 1,1$. The load value for triggering shall be measured after filtering out the dynamic effects.

A load greater than α times the maximum hoist load - specific for each load/radius - shall not be lifted from the ground higher than the maximum rated hoisting speed multiplied by 1 second. See 5.2.4 for overload calculations.

5.5.1.3.2 Luffing

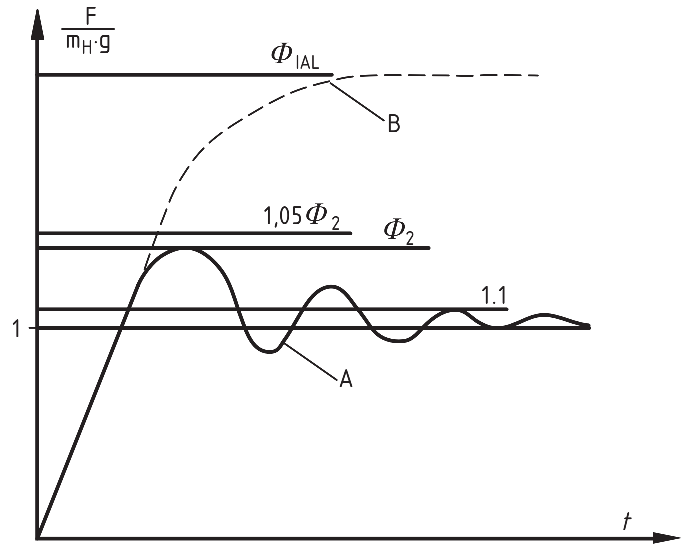
An immediate stop shall be triggered on attaining load/radius design limitations. After triggering, the control system shall allow the jib to be luffed in so that the crane can continue operating.

5.5.1.4 Stall load protection

The triggering point of immediate stop shall be set, accuracy of the device included, no more than 5 % higher than the expected dynamic influence of the hoist load; see Figure 1.

NOTE 1 For hydraulic hoist drives the direct acting hoist force limiter may be considered as stall load protection.

NOTE 2 The purpose of stall load protection is to override filtering delays which are needed to provide overload protection. The stall load protection minimises the induced forces in cases, when attempting to lift "large overloads" or where the load is locked to ground.



Key

A hoisting a nominal load

B stall load case

Figure 1 — Load F in the hoist system by time t

5.5.2 Indicators

Cranes with a rated capacity of 1 000 kg or above, or an overturning moment of 40 000 Nm or above due to the load shall be fitted with rated capacity and radius indicators in accordance with 5.7 of EN 12077-2:1998+A1:2008. Cranes operating in areas where the in-service design wind speeds can be exceeded shall be fitted with wind speed indicators, unless other means are continuously available for the operator to receive the necessary information.

The rated capacity indicator shall give visual and audible warnings in accordance with the provisions of 5.5.1, 5.5.2 and 5.5.3 of EN 12077-2:1998+A1:2008. It shall give a visual warning at 90 % of the rated capacity and a visual and audible warning at overload.

5.5.3 Motion limiters

Motion limiters shall be provided in accordance with EN 12077-2:1998+A1:2008, 5.6.1 on the hoisting, lowering and luffing motions. Additional limiters shall be provided in accordance with EN 12077-2:1998+A1:2008, 5.6.1.1 dependent upon the application, location and capacity of the crane, determined by risk assessment. The limiters shall actuate a category 0 or 1 stop but allow movement in the opposite direction to a safe condition.

Where a risk assessment has determined that secondary (‘back-up’) limiter is needed, it shall conform to EN 12077-2:1998+A1:2008, 5.6.1.4.

NOTE ISO 10245-4:2004, 5.1 gives additional information on motion limiters.

5.5.4 Performance limiters

Performance limiters shall be provided in accordance with the provisions of 5.6.2.1 of EN 12077-2:1998+A1:2008.

5.6 Protection against special hazards

5.6.1 Hot surfaces

Potentially hot surfaces, which can be touched unintentionally from access ways, shall be guarded or marked according to EN ISO 13732-1:2008, Annex B.

5.6.2 Radio equipment

The operating frequency of the radio equipment used on the crane shall not interfere with or be disturbed by other radio equipment in the area.

5.6.3 Laser beams

Laser beams shall be used on cranes only in special cases, such as for measuring distances or for data transmission.

The laser equipment shall be in accordance with EN 60825-1.

5.6.4 Fire hazard

Fire extinguishers shall be provided in locations where fire hazard exists including operator's cabin, machinery and electrical rooms. Exits from these rooms shall conform to the access requirements of 12.5.2 and 12.5.3 of EN 60204-32:2008.

5.6.5 Exhaust gases

Exhaust gases from combustion engines shall be discharged so that the risks to the driver and others in the vicinity are minimised.

5.6.6 Fuelling

The filling opening for the fuel tank shall not be located in the operator's cabin. The filling position shall be easily accessible, preferably from ground level.

5.7 Man-machine interface

5.7.1 Controls and control stations

5.7.1.1 Control and control systems

Controls and control systems shall comply with 5.1 of EN 13557:2003+A2:2008 amended as follows:

The arrangement of the controls for cranes with cabins shall comply with ISO 7752-4. The logic of the control arrangement shall be the same at each control station associated with the operation of the crane. The arrangement of the controls for the cranes without cabins shall, where possible, also follow this logic.

The movement of a crane motion shall only be able to be initiated from the neutral position of the control.

5.7.1.2 Control stations

Control stations shall comply with 5.2.1 of EN 13557:2003+A2:2008.

NOTE More information on ergonomic design principles of controls and control stations is given in EN 614-1.

5.7.1.3 Cabins

Cabins shall be constructed as specified in ISO 8566-4 as amended below.

Means shall be provided to keep the air temperature inside the closed cabin at 18 °C minimum at a reference outside temperature of –10 °C. The cabin shall be such as to protect against draughts.

The cabin shall be provided with adjustable ventilating equipment. The equipment shall be capable of supplying air from the outside. The fresh air valve shall be adjustable.

Windows shall be fitted with wipers and washers and designed so that the outside surface can be readily cleaned. The whole window unit shall be designed and installed so that it cannot fall outwards.

The cabin shall be located so that collision with the handled load is prevented. If this is not possible by location, the cabin shall be guarded with railings.

5.7.1.4 Consoles

Consoles shall comply with 5.2.3 of EN 13557:2003+A2:2008.

5.7.2 Guarding and access

The crane shall comply with EN 13586.

Where there is a danger of a shearing hazard occurring on frequently used access ways (Type 1), the transfer points shall be provided with interlocked gates, which disable the relevant motion. For less frequent points of access (Type 2), warning labels, highlighting the dangers, and devices to disable the relevant motions, shall be fitted.

If maintenance or inspection requires access to enclosures, the openings of those enclosures shall conform to EN 547-1 and EN 547-2.

Open gears, chain drives and similar power transmissions in permanent access zones shall be guarded according to EN 953. Exceptionally, guarding of the large slewing gears may not be required, if the drawing-in point of the pinion/gear is located sufficiently remote from the frequently used access ways (Type 1), in accordance with EN ISO 13857.

Hook block design shall minimise the risk of drawing-in the hand between the rope and a sheave.

NOTE For functional and inspection reasons the rope drums, brakes and couplings are not generally covered or guarded, as there should be no people near the machinery during normal crane operation.

5.7.3 Lighting

Lighting shall be installed in the various parts of the crane to the minimum levels indicated below:

- cabins 200 lux;
- access ways 20 lux;
- machinery rooms 100 lux;
- electric rooms 100 lux.

A socket for extra local light shall be provided in each room including the cabin, in electrical cubicles, and other points requiring maintenance, if the fixed lighting and/or the ambient illumination is not adequate.

Cranes with a ride-on driver shall be equipped with battery powered emergency exit lighting, unless there is emergency illumination on site of a minimum level of 5 lux.

NOTE The manufacturer should clarify with the user the need for crane-mounted lights to illuminate the working area.

5.7.4 Reduction of noise by design

5.7.4.1 General

Normally noise is not a significant hazard in slewing jib cranes. Noise may be a significant hazard in cases where the operator's position is situated close to one or more of the mechanisms or components mentioned in 5.4, when their power level or operational speed is high. Where noise is a significant hazard this clause and Annex D give relevant information concerning design of low noise equipment.

When noise is a significant hazard there is need for low noise design. In this case the methodology for low noise design in EN ISO 11688-1 shall be considered.

NOTE EN ISO 11688-2 gives useful information on noise generation mechanisms in machinery.

5.7.4.2 Main sources of noise

On a slewing jib cranes the main sources of noise are from the following:

- hoisting mechanism (motor, gears, brakes);
- slewing mechanisms (motor, gears, brakes);
- luffing mechanism (motor, gears, brakes);
- crane travel mechanism (motor, gear, brakes, especially rail/wheel contact);
- electrical cubicles;
- external devices, e.g. motor fans;
- hydraulic pumps, either on the crane or in the load lifting attachment (especially the grabs);
- combustion engines and power generators.

5.7.4.3 Measures to reduce noise at the source

Typical measures to reduce noise are:

- selection of low noise components;
- use of elastic mountings that prevent the transmission of structure born noise from the components to the structures.

Other measures of identical or better efficacy can be used.

5.7.4.4 Protective measures

Typical measures are:

- the use of noise reducing housing around noisy components
- the use of improved noise insulation of the cabin, if any.

5.7.4.5 Determination of noise emission values

Noise emission values shall be determined as specified in the noise test code given in Annex D.

NOTE Effects of the supporting structure and the surrounding buildings (if applicable) are outside of the scope of this standard.

5.7.4.6 Information on residual noise

The information on residual noise shall be given to the user; see 7.3.

5.8 Equipment for information and warning

5.8.1 General

Warning labels and markings shall be fitted as necessary to inform about the residual risks related to the crane and its operations.

NOTE 1 EN ISO 12100 gives the principles of presenting hazard information using labels.

NOTE 2 EN 12644-2 gives requirements and information on the marking of the crane.

5.8.2 Location of visual display units

Location of the visual display units shall be designed according to EN 894-1 and EN 894-2 to minimise the operator's head movements but still avoiding unnecessary hindrance of the field of vision over the working area.

5.8.3 Safety colour

Safety colours shall be of contrasting colours, which will cause the “warning marks” to stand out of the operating environment, according to ISO 3864 (all parts). Colours shall have reasonable life for the anticipated operating environment.

5.8.4 Warning lights

Flashing warning lights shall be installed on ground travelling cranes to attract the attention of personnel, when the crane is travelling. Lights shall be installed in such a manner as to be visible from the normal position of crane operators.

The colour of the flashing warning lights shall be yellow or amber and the flashing rate shall be 60/min to 120/min.

6 Verification of the safety requirements and/or protective measures

6.1 General

Conformity to the safety requirements and/or protective measures given in Clause 5 shall be verified using the methods given in Table 3 and Table 4.

NOTE Where applicable, individual components may be separately verified or tested.

Table 3 — Verification methods for requirements

Visual inspection	**V**
Measurement	**M**
Testing	**T**
Calculation	**C**
Engineering assessment	**EA**

Table 4 — Methods to be used to verify conformity with the safety requirements and/or protective measures

Clause number	Title of the clause	Method of verification
5.1	General	**EA**
5.2 and sub-clauses	Requirements for strength and stability	**C, EA**
5.3.1	General	**EA**
5.3.2	Physical environment and operating conditions	**EA**
5.3.3	Electrical supply	**EA**
5.3.4	External protective earthing and equipotential bonding	**V, T**
5.3.5	Supply disconnecting and switching off	**V, T**
5.3.6.1	Protection against electric shock by direct contact	**EA, V**
5.3.6.2	Protection against electric shock by indirect contact	**EA, V, T**
5.3.7.1	General	**EA, V, T**
5.3.7.2	Collector wires, collector bars and slip-ring assemblies	**V, EA**
5.3.7.3	Wiring practice	**EA**
5.3.8.1	General	**EA, V, T**
5.3.8.2	Suspension of safeguarding	**V**
5.3.8.3	Combined start and stop controls	**V**
5.3.9.1	General	**EA, V**
5.3.9.2	Push-buttons	**V**
5.3.9.3	Indicator lights	**V**
5.3.9.4	Emergence stop	**V, T**
5.3.10	Control gear – Location, mounting and enclosures	**EA, V**
5.3.11	Electrical requirements for the installation of load handling devices	**EA, V, T**

5.3.12	Electric motors	**EA, C, T**
5.4.1	General	**EA**
5.4.2.1	General	**V, T**
5.4.2.2	Service brakes	**V, T**
5.4.2.3	Brakes for hoisting and luffing jib movements	**V, C, M, T**
5.4.3.1	Dual hoist mechanism	**EA, T**
5.4.3.2	Speed change gear	**V, T**
5.4.4.1	Mechanism	**EA, C, T**
5.4.4.2	Dual luffing elements	**V, T**
5.4.4.3	Brakes for dual luffing elements	**V, C, T**
5.4.5.1	Parking in out-of-service condition	**V, C**
5.4.5.2	Slew bearing	**V, C**
5.4.6.1	Friction drive capacity	**C,T**
5.4.6.2	Anchoring in out-of-service wind conditions	**C, V, T**
5.4.6.3	Bogies, wheels and tracks	**EA, C, V**
5.4.7	Gear drives	**EA, C**
5.5.1.1	General	**C, V**
5.5.1.2	Operation	**V, T**
5.5.1.3.1	Hoisting	**C, T**
5.5.1.3.2	Luffing	**T**
5.5.1.4	Stall load protection	**C**
5.5.2	Indicators	**V, C, T**
5.5.3	Motion limiters	**V, T**
5.5.4	Performance limiters	**EA, V, T**
5.6.1	Hot surfaces	**V, M**
5.6.2	Radio equipment	**EA, T**
5.6.3	Laser beams	**EA, M**
5.6.4	Fire hazard	**EA, V**
5.6.5	Exhaust gases	**V, T**

5.6.6	Fuelling	**V**
5.7.1.1	Control and control systems	**EA, V**
5.7.1.2	Control stations	**EA, V**
5.7.1.3	Cabins	**EA, C, V, M**
5.7.1.4	Consoles	**EA, V**
5.7.2	Guarding and access	**EA, M, V**
5.7.3	Lighting	**EA, V, T, M**
5.7.4.1	General	**EA, M, V**
5.7.4.2	Main sources of noise	**V**
5.7.4.3	Measures to reduce noise at the source	**EA, C, V**
5.7.4.4	Protective measures	**V**
5.7.4.5	Determination of noise emission values	**EA, V, M, T, C**
5.7.4.6	Information on residual noise	**V**
5.8.1	General	**EA, V**
5.8.2	Location of visual display units	**EA, V**
5.8.3	Safety colour	**EA, V**
5.8.4	Warning lights	**V, M**

6.2 Fitness for purpose testing

6.2.1 General

Testing of each crane shall be carried out on the operational site under normal operating conditions before the crane is taken into service to ensure that the crane is able to fulfil its specified functions safely. The manufacturer shall prepare a programme to present the details of the testing.

6.2.2 Tests

6.2.2.1 Functional test

All motions of the crane shall be operated throughout their range of movements up to the maximum operating speeds and rated capacity in combinations one with another so as to simulate normal operating arrangements in the following order:

a) No load;

b) 100% of rated capacity.

During these tests the crane shall be continuously monitored to check:

c) the smooth operation of the crane;

d) the effectiveness of the braking system;

e) the effectiveness and the accuracy of the limiting and indicating devices;

f) that the electric motor currents are within the values shown on the motor nameplates or according to crane documentation;

g) the mechanisms for signs of damage or wear;

h) the structure for deformations and damage.

6.2.2.2 Static test

A static test shall be performed with test loads as shown below. The applied static test load shall be such that the resulting total load in the test is the greater of the following:

a) $\psi \times m_{RC} + m_{LA}$

b) $\phi_2 \times (m_{RC} + m_{LA})$

where

ψ is the test load coefficient according to Table 5;

ϕ_2 is the ϕ_2 -factor that has been used in design calculation in load combinations A;

m_{RC} is the mass of the rated capacity;

m_{LA} is the mass of the fixed lifting attachments;

g is the gravity constant.

Table 5 — Test load coefficient ψ

Mass of rated capacity	Test load coefficient
$m_{RC} \leq 20$ t	1,50
20 t < $m_{RC} \leq 120$ t	1,56 – 0,003 m_{RC} [t]
120 t < m_{RC}	1,20

The test load shall be applied progressively until the crane is subjected to the full test static load.

During the test the crane shall be monitored for stability, the structure and mechanisms for damage and the brakes for efficiency.

The static test shall be carried out in one or more of the critical boom positions, with the test loads related to the rated capacity of each boom position. The static test shall not be carried out in wind speeds in excess of the manufacturers recommended wind speed during testing.

The static tests cover the requirements for the stability testing.

When more than one hoisting mechanism is used in a crane, the overload testing shall be carried out in the most unfavourable combinations of loads in the specified use. In addition, each hoisting mechanism shall be overload tested individually.

Each hoisting mechanism shall be overload tested:

c) with individual loads; or

d) with one common load, when:

   1) the individual hoisting mechanisms, including their drives and controls, have been overload tested in advance; and

   2) the adequate distribution of load between the hoists is assured.

At the conclusion of static testing, limiters, both stall and overload shall be reset to the design nominated values and qualified.

6.2.2.3 Dynamic test

Dynamic tests shall be performed with a test load that is at least 110 % of the rated capacity. The crane shall be operated with maximum operating speeds combining the different motions so as to simulate normal operating arrangements. However, special care shall be taken at the extreme positions of the working ranges.

During these tests the crane shall be monitored in accordance with the provisions of items c) to h) of 6.2.2.1 above.

7 Information for use

7.1 Instructions for installation and safe use

The crane shall be provided with instructions in accordance with 6.4 of EN ISO 12100:2010, EN 12644-1 and subclauses 7.2 to 7.6 of this standard.

In cases that it is foreseen that the manufacturer will not carry out the assembly or erection of the crane, instruction on the slinging of major structural items and components shall be given.

7.2 Driver's manual

If there is more than one hoist mechanism on the crane or there are special limitations for the rated capacity dependent on radius outreach, a full description of the rated capacity of each hoist and rated capacities at varying outreaches shall be given. Description of the operation of the load limiter(s) and indicator systems shall also be included.

To avoid accidental release of the load from the hook, the driver’s manual shall give instructions on safe slinging.

The driver’s manual shall warn of hazards related to falling of the load or a part of the load in case of a failure in the load bearing components or a failure in compiling and attaching the load.

The driver’s manual shall give information on correct operation of the crane in order to avoid damage to persons or property by the moving load.

Instructions shall be provided on means of ensuring condition, installation and operation of the warning devices.

The crane driver's instructions shall provide information on the correct ways of using multiple commands in order to suppress the sway instead of boosting it.

Information on the safe use of brake manual release facilities shall be provided.

Instructions regarding speed change procedures shall be provided. The driver's manual shall provide information on the procedure for shutting down the crane and leaving it in out-of-service condition.

7.3 User's manual

The user's manual shall provide a description and explanation concerning the use, classification, rated capacity, design limits and operating conditions, for which the crane has been designed and manufactured. In particular, in service wind and out of service wind speeds shall be specified and displayed in the driver's cabin.

Emission sound pressure levels at the operator positions, generated by the crane, determined in accordance with Annex D shall be indicated.

NOTE 1 When the crane is used in noisy environment the operators and service personnel may need to use ear protection.

Where it is considered that these sound levels may disturb communications between the operator and the slingers or other personnel, the user's manual shall draw attention to arrangements of other means of communications e.g. hand signals, radios.

Where the crane is not equipped with an automatic clamping system for anchoring in out-of-service conditions, the user's manual shall provide a formula (or a table) of the wind speed at which the use of the crane shall be stopped and the crane shut down.

NOTE 2 Wind speed v_{st} for stopping the crane by a formula.

$$v_{st} = \left[v_p^2 - (2300 \times t)^{0.5}\right]^{0.5}$$

where

v_{st} is the wind speed for stopping the crane, m/s;

v_p is the permissible in-service wind speed, m/s;

t is the time needed to shut down the crane, min.

NOTE 3 The method of measuring the wind speed should be agreed between the user and the manufacturer.

The user's manual shall draw attention to the following mental stresses, which can cause loss of awareness and increase risk of operator error:

— mental underload of the crane driver, if the operator actions are required only infrequently resulting from lack of work or too advanced automation;

— lack of attention to detail due to repetitive operation.

If the crane manufacturer supplies the anti-collision system with the crane, the full description of its functions shall be supplied to the user.

The loads transmitted to the rails or the ground shall be indicated.

7.4 Instructions for regular checks, inspections and tests

Instructions for inspection methods and intervals as well as criteria for the replacement of components shall be given. In addition, instructions shall be provided in accordance with EN 12644-1, EN 60204-32 and EN 13135-2.

The manufacturer should list the components and define abrasion and wearing limits, including but not limited to:

a) hoisting mechanisms, consisting of:

   1) sheaves;

   2) ropes (ISO 4309), pins and rope terminals;

   3) rope drums;

   4) hooks;

   5) brake linings, discs, drums;

   6) couplings;

   7) slipring elements in motors; and

b) travelling and slew mechanisms, consisting of:

   1) wheels;

   2) chains and sprockets;

   3) travel rails;

   4) guide rollers;

   5) slew bearing and its mounting.

Instructions for checking the crane condition after a lightning strike shall be provided. These shall include the following requirements:

— if during the working period the crane is subject to a lightning strike, the initial start-up procedures, proving limits, overload detection systems, etc. shall be repeated; in addition, the hoist rope and any motion bearing shall be inspected for damage;

— if a lightning strike is considered to have occurred in the out of service condition, the hoist rope and motion bearings shall be inspected before setting to work.

The triggering point of the overload limiter, with its tolerance, shall be recorded in the log book of the crane. The manufacturer shall provide information on how to check that the setting has not changed by time, and how to reset the triggering value.

7.5 Instructions for maintenance

The manufacturer shall provide maintenance intervals and procedures. Maintenance manual shall include instructions on replacement of worn out or damaged parts.

The operator's and maintenance manuals shall indicate which components are potentially hot to the touch and touching of which is therefore to be avoided.

The maintenance manual shall give instructions on disposal of all materials that are replaced during maintenance and final dismantling.

7.6 Markings

Markings on the crane shall comply with EN 12644-2.

The rated capacity shall be marked in a prominent position on the structure.

EXAMPLE RC 20t.

8 Information to be obtained from the purchaser

The manufacture shall obtain the information set out in ISO 9374-4 from the purchaser.

Annex A
(informative)

Guidance for classification according to EN 13001-1

A.1 Total number of working cycles

Total numbers of working cycles is the sum of the working cycles through all the different work tasks that the crane carries out during its total design life. A working cycle comprises both the work part and the return part of a work cycle. Total numbers of working cycles (C) can be expressed as any fixed number or it can be selected from a series of numbers by specifying the class U; see Table A.1 and Table A.2.

Specify for the crane either:

a) total number of working cycles C = ☐

or

b) class U = ☐

Table A.1 —Determining of number of working cycles C by class U

Class	Total number of working cycles for design calculations
U_0	$C = 1{,}60 \times 10^4$
U_1	$C = 3{,}15 \times 10^4$
U_2	$C = 6{,}30 \times 10^4$
U_3	$C = 1{,}25 \times 10^5$
U_4	$C = 2{,}50 \times 10^5$
U_5	$C = 5{,}00 \times 10^5$
U_6	$C = 1{,}00 \times 10^6$
U_7	$C = 2{,}00 \times 10^6$
U_8	$C = 4{,}00 \times 10^6$
U_9	$C = 8{,}00 \times 10^6$

Table A.2 — Guidance for selection of class U, slewing jib cranes

No.	Type of operation	U-class
1	Assembly and maintenance cranes, intermittent operation	U_1 to U_3
2	Factory and warehouse cranes, intermittent operation	U_2 to U_5
3	Shipbuilding cranes , hook service	U_2 to U_5
4	Scrap-yard cranes, grabbing or magnet service	U_7 to U_9
5	Container cranes in harbours	U_6 to U_8
6	Unloading cranes, grabbing or magnet service	U_6 to U_9
7	Slewing cranes in general, hook service	U_2 to U_5
8	Slewing cranes in general, grabbing or magnet service	U_6 to U_9
9	Railroad cranes	U_2 to U_4
10	Wharf cranes (dockside crane, hook service)	U_4 to U_6

A.2 Load spectrum factor kQ

The load spectrum factor kQ is a parameter to specify the different net loads to be handled during the working cycles. In case the different net loads for a specific number of work cycles are known or can be estimated, the load spectrum factor kQ can be calculated as follows:

$$kQ = \sum_{i=1}^{n} \frac{C_i}{C} \times \left(\frac{Q_i}{Q} \right)^3 \quad \text{(A.1)}$$

where

n is the number of working sequences, where in each working sequence a constant net load at a level of Q_i is handled;

C_i is the number of working cycles in a sequence, where a net load i of magnitude Q_i is handled;

C is the total number of working cycles (i.e. summation of C_i 's);

Q_i is the magnitude of a net load i constant within a working sequence;

Q is the maximum net load of the crane.

Where details concerning the numbers of working cycles and the masses of the particular net loads to be handled are not known, an appropriate Q-class of the load spectrum factor shall be specified for the crane; see Table A.3 and Table A.4.

Alternatives to determine the load spectrum factor are either:

a) by calculation of kQ = [ ]

or

b) by specifying the class Q = [ ]

Table A.3 — Determining of load spectrum factor kQ by class Q

Class	Load spectrum factor for design calculations
Q_0	kQ = 0,031 3
Q_1	kQ = 0,062 5
Q_2	kQ = 0,125 0
Q_3	kQ = 0,250 0
Q_4	kQ = 0,500 0
Q_5	kQ = 1,000 0

Table A.4 — Guidance for selection of class Q, slewing jib cranes

No.	Type of operation	Q-class
1	Assembly and maintenance cranes	Q_0 to Q_3
2	Factory and warehouse cranes	Q_1 to Q_3
3	Shipbuilding cranes, hook service	Q_0 to Q_3
4	Scrap-yard cranes, grabbing or magnet service	Q_3 to Q_5
5	Container cranes in harbours	Q_2 to Q_4
6	Unloading cranes, grabbing or magnet service	Q_3 to Q_5
7	Slewing cranes in general, hook service	Q_1 to Q_3
8	Slewing cranes in general, grabbing or magnet service	Q_2 to Q_4
9	Railroad cranes	Q_1 to Q_3
10	Wharf cranes (dockside crane, hook service)	Q_1 to Q_3

A.3 Classification of the hoist mechanism

In addition to the above parameters *Total numbers of working cycles* and *Load spectrum factor*, a third parameter is needed to specify completely the required capacity of the hoist mechanism. An average displacement of the load X_{lin} expresses the range that the hoist mechanism moves as an average in a working cycle. This displacement may be classified and chosen according to Table A.5, or it can be calculated through all the load cycles C. For a simplified work cycle as illustrated in Figure A.1 it is calculated as follows:

$$X_{lin} = \frac{1}{C}\sum_{i=1}^{C}\left(\Delta x_{H,i} + \Delta x_{L,i}\right) \tag{A.2}$$

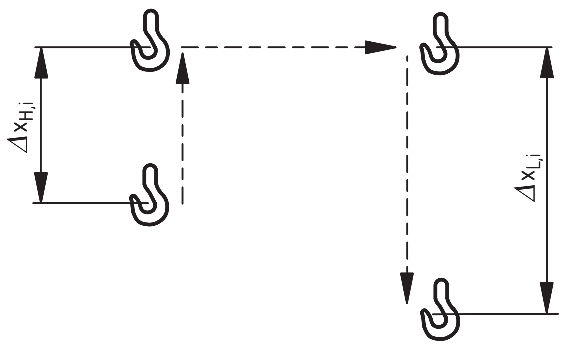


Figure A.1 — Hoist displacement in a work cycle

The displacement ($\Delta x_{H,i} + \Delta x_{L,i}$) represents the loaded part of a work cycle, i.e. the distance the load is moved during a work cycle. For the proof calculation of the mechanism, the loading of the return movement shall also be considered. The displacement of the return movement is not included in X_{lin}; that may be same or differ from X_{lin}. It is assumed that the whole lifting range $x_{max} - x_{min}$ is covered uniformly, and that the loads between different displacements Δx_i do not differ from each other systematically. See also EN 13001-1.

Table A.5 — Classes D of mechanism

Class	Average displacement X_{lin} for design calculations m
$D_{\text{lin }0}$	X_{lin} = 0,63
$D_{\text{lin }1}$	X_{lin} = 1,25
$D_{\text{lin }2}$	X_{lin} = 2,5
$D_{\text{lin }3}$	X_{lin} = 5
$D_{\text{lin }4}$	X_{lin} = 10
$D_{\text{lin }5}$	X_{lin} = 20
$D_{\text{lin }6}$	X_{lin} = 40
$D_{\text{lin }7}$	X_{lin} = 80
$D_{\text{lin }8}$	X_{lin} = 160
$D_{\text{lin }9}$	X_{lin} = 320

For classification of the hoist mechanism, either:

a) calculate the average displacement X_{lin} = [ ]

or

b) choose the class D_{lin} for hoisting = [ ]

A.4 Classification of the luffing mechanism

The range that the luffing mechanism moves as an average in a working cycle is expressed by an average displacement X_{lin} of the load in the radial direction. This may be classified and chosen according to Table A.5, or it can be calculated based on the planned operation of the crane.

Basically X_{lin} is the average of the luffing displacements through all the load cycles C. In a simple operation, where in each work cycle the load is moved only once from a radius $R_{O,i}$ to another radius $R_{I,i}$, the X_{lin} is calculated as follows:

$$X_{lin} = \frac{1}{C} \sum_{i=1}^{C} \left| R_{O,i} - R_{I,i} \right| \quad \text{(A.3)}$$

If the operation of the luffing motion can be grouped to few working ranges (WR) as illustrated in Figure A.2, the average luffing displacement can be calculated as follows:

$$X_{lin} = \frac{1}{C}\sum_{i=1}^{N_{WR}} C_i \times \left| R_{O,i} - R_{I,i} \right| \qquad (A.4)$$

Data needed to specify the working ranges in a simple, basic operation is shown in Table A.6, with example values filled into the table. Specifying the working ranges and consequently using Equation (A.4) is recommended, as the different loading conditions of the luffing mechanism at different load radius can be considered in the design calculations.

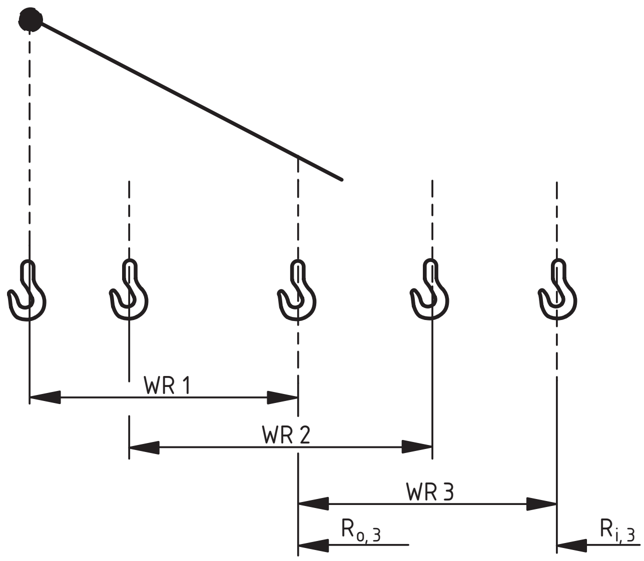


Figure A.2 — Luffing displacements in working ranges

Table A.6 —Specification of working ranges for luffing motion with example values

	Working range WR 1	**Working range WR 2**	**Working range WR 3**	**etc.**
Outer radius R_O	32 m	30 m	26 m	
Inner radius R_I	26 m	22 m	14 m	
Number of working cycles C_I	80 000	140 000	160 000	
Average net load Q_i	24 t	24 t	35 t	

The displacements $R_{O,i}$.-$R_{I,i}$ represent the loaded part of the work cycles, i.e. the distance the load is moved during a work cycle. For the proof calculation of the mechanism, the loading of the return movement shall also be considered.

Specify for the crane the typical working ranges according to example presented in Table A.6. Specify as many working ranges as necessary to describe the typical crane use.

For classification of the luffing mechanism, either:

a) calculate the average luffing displacement X_{lin} = [ ]

or

b) choose the class D_{lin} for luffing =
(Table A.5)

A.5 Classification of the slewing mechanism

The range that the slew mechanism moves as an average in a working cycle is expressed by an average angular displacement X_{ang} of the load in the slew direction. This may be classified and chosen according to Table A.7, or it can be calculated based on the planned operation of the crane.

Basically X_{ang} is the average of the slewing displacements through all the load cycles C. In a simple operation, where in each work cycle the load is moved only once through each slewing sector α_i, the X_{ang} is calculated as follows:

$$X_{ang} = \frac{1}{C}\sum_{i=1}^{C}\alpha_i \quad \text{(A.5)}$$

If the operation of the slew motion can be grouped to few working ranges (WR) as illustrated in Figure A.3, the average slewing displacement can be calculated as follows:

$$X_{ang} = \frac{1}{C}\sum_{i=1}^{N_{WR}} C_i \times \alpha_i \quad \text{(A.6)}$$

Data needed to specify the working ranges in a simple, basic operation is shown in Table A.7, with example values filled into the table. Specifying the working ranges and consequently using Equation (A.6) is recommended, as the different loading conditions of the slewing mechanism at different load radius can be considered in the design calculations.

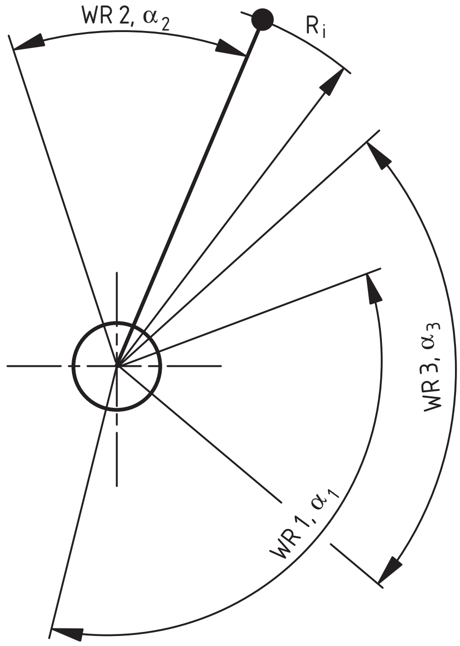


Figure A.3 — Slewing displacements and working ranges

Table A.7 — Specification of working ranges for slewing motion with example values

	Working range WR 1	**Working range WR 2**	**Working range WR 3**	**etc.**
Average radius R_i	29 m	26 m	20 m	
Working sector α_i	120°	70°	90°	
Specified number of working cycles	80 000	140 000	160 000	
Average net load Q_i	24 t	24 t	35 t	

Table A.8 — Classes D of mechanism

Class	**Average angular displacement for design calculations**	
	X_{ang} [°]	X_{ang} [radians]
$D_{ang\ 0}$	X_{ang} = 11,3	$X_{ang} = \pi/16$
$D_{ang\ 1}$	X_{ang} = 22,5	$X_{ang} = \pi/8$
$D_{ang\ 2}$	X_{ang} = 45	$X_{ang} = \pi/4$
$D_{ang\ 3}$	X_{ang} = 90	$X_{ang} = \pi/2$
$D_{ang\ 4}$	X_{ang} = 180	$X_{ang} = \pi$
$D_{ang\ 5}$	X_{ang} = 360	$X_{ang} = 2\pi$

The slewing sectors α_i represent the loaded part of the work cycles, i.e. the sector the load is moved during a work cycle. For the proof calculation of the mechanism, the loading condition of the return movement shall also be considered.

Specify for the crane the typical working ranges according to example presented in Table A.8. Specify as many working ranges as necessary to describe the typical crane use.

For classification of the slewing mechanism, either:

a) calculate the average displacement X_{ang} **=**	
or	
b) choose the class D_{ang} **for Slewing =** (Table A.8)	

Annex B
(normative)

Load combinations

Table B.1 — Description of load combinations

Load combinations	Description
A1 and B1	Jib cranes normally lifting an unrestrained grounded load (see EN 13001-2) together with two other engaged motions selected from those available to produce maximum loading, without in-service wind and other climatic effects (A1), and with in-service wind and other climatic effects (B1).
A2 and B2	Jib cranes under normal service conditions having a facility to suddenly release part of the hoisted load (see EN 13001-2). This action shall be combined with two other engaged motions selected from those available to produce maximum loading, without in-service wind and other climatic effects (A2), and with in-service wind and other climatic effects (B2).
A3 and B3	Jib cranes under normal service conditions accelerating the suspended load (see EN 13001-2). This action shall be combined with two other engaged motions selected from those available to produce maximum loading, without in-service wind and other climatic effects (A3), and with in-service wind and other climatic effects (B3).
A4 and B4	Jib cranes under normal service conditions travelling on an uneven surface (see EN 13001-2). The resultant loading shall be combined together with two other engaged motions selected from those available to produce maximum loading, without in-service wind and other climatic effects (A4), and with in-service wind and other climatic effects (B4).
B5	Jib cranes under normal service conditions travelling on an uneven track surface at constant speed and skewing (see EN 13001-2) with in-service wind and other climatic effects.
C1.1	Jib cranes under in-service conditions, hoisting a grounded load under the exceptional circumstances depicted in EN 13001-2.
C1.2	Jib cranes under in-service conditions, stall load condition according to 5.2.4.
C2	Jib cranes under out-of-service conditions, including out-of-service wind and loads from other climatic effects.
C3	Jib cranes under test conditions. The hoisting action shall be combined together with two other engaged motions to produce maximum loading.
C4 to C8	Jib Cranes, where applicable, with gross load in combination with loads such as buffer forces, (C4); tilting forces, (C5); emergency cut-out, (C6); failure of mechanism, (C7); and excitation of crane foundation, (C8) shall be taken into account.

Annex C
(informative)

Calculation of stall load factor for indirect acting lifting force limiter

Indirect acting lifting force limiters measure the load using a sensor and override the controls to prevent excessive loading by bringing the motion to rest. Evaluation of the measured values and filtering of interference signals take time and act as a triggering delay. An additional time delay takes place before the braking torque is applied.

The stall load factor ϕ_{IAL} for indirect acting lifting force limiters can be calculated as follows:

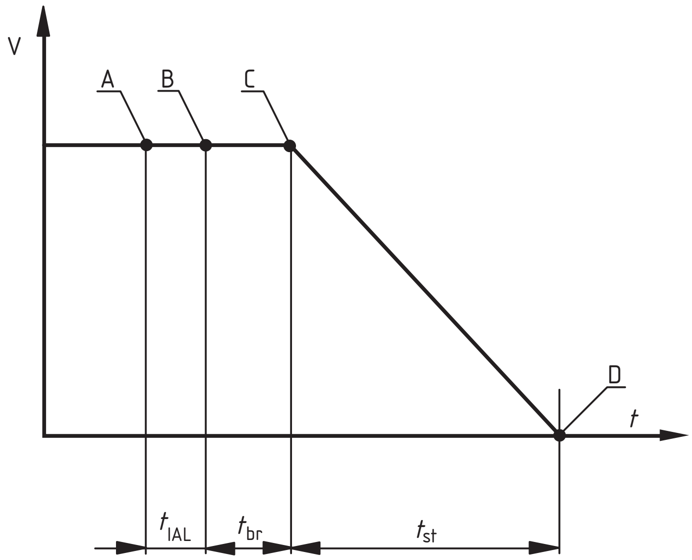
$$\phi_{IAL} = 1{,}05 \times \phi_2 + \left\{ C_H \times v_h \times (t_{IAL} + t_{br} + \frac{t_{st}}{2}) \right\} / (m_H \times g)$$

where

- ϕ_2 is the ϕ_2 -factor for load combination A1; see 5.2.3;
- v_h is the maximum hoisting speed at which the indirect acting force limiter may be triggered, in m/s;
- m_H is the mass of the hoist load, in kg;
- t_{IAL} response-time of the indirect acting lifting force limiter, in s;
- t_{br} reaction time of the braking, in s;
- t_{st} time to stop the mechanism in stall condition by effects of the braking and increasing rope force, in s;
- C_H is elasticity factor of crane structure and rope system at the load suspension point, in N/m.

The term 1,05 × ϕ_2 represents the triggering point of immediate stop of the indirect acting limiter, see 5.5.1.4.

The assumed, simplified triggering and stopping process is illustrated in Figure C.1.



Key

A triggering happens

B braking receives the stopping instruction

C braking is applied

D the hoist mechanism has stopped

Figure C.1 — Hoist mechanism speed (v) by time (t) at immediate stop with indirect acting lifting force limiter

Annex D
(normative)

Noise test code for slewing jib cranes

D.1 General

This noise test code specifies all the information necessary to carry out efficiently and under standardized conditions the determination, declaration and verification of the noise emission characteristics of slewing jib cranes.

Noise emission characteristics include emission sound pressure levels at operator's positions. The determination of these quantities is necessary for:

- manufacturers to declare the noise emitted;
- comparing the noise emitted by machines in the family concerned;
- purpose of noise control at the source at the design stage.

The use of this noise test code ensures reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise determination methods offered by this standard are:

- A calculation method (D.3) to determine the overall noise emitted by the noisiest components of the crane.
  This method shall be used systematically during the design stage by the manufacturer to ensure that a low noise emission crane is being produced. This method underestimates the actual noise emission value of the crane when installed at the user's place;
- A measurement method (D.4) of the sound pressure level at the operator's and other specified positions. This sound pressure level is strictly speaking not an emission sound pressure level because it includes not only the crane but also the structure to which the crane is fixed. This method determines two values, one for the work cycle without travelling and, where the crane is designed to travel, another for the travelling of the crane. For the emission sound pressure level at the operator's positions, both values have to be considered. The actual value may be higher than the biggest of them, when there is a situation where travelling occurs with other motions at the same time. The latter situation is not covered by this noise test code.

The C-weighted peak emission sound pressure levels in slewing jib cranes are typically so low that they do not need to be measured and declared.

D.2 Description of machinery family

This annex is applicable to individual slewing jib cranes, within the scope of this European Standard, fully assembled in the intended working condition including the fixed load lifting attachment.

D.3 Determination of a conventional emission sound pressure level by calculation

D.3.1 Principle of the method

A conventional emission sound pressure level at the operator's positions shall be calculated as the summation of the contributions at each position of the main noise sources present on the crane. These contributions shall be derived from the sound power levels of these main noise sources as provided by their manufacturer.

Figure D.1 indicates noise sources and a single operator position for a typical medium sized crane. Depending on the design of the crane, there could be a number of driver positions including the ground.

D.3.2 Calculation

The contribution of a given noise source with A-weighted sound power level L_{WA} is given by the following equation:

$$L_{pA} = L_{WA} - 10\lg\left(\frac{S}{S_0}\right)$$

where

L_{pA} is the resulting A-weighted sound pressure level at the operator's position;

L_{WA} is the A-weighted sound power level of the source, in decibels; reference:1 pW;

$S = 2\pi r^2$, where r is the distance between the considered place and the sound source;

$S_0 = 1\ \text{m}^2$.

The values of the sound power level of the components to be used in the calculation shall correspond to the rated capacities and speeds of the crane.

The noise sources to be taken by the calculation are:

— hoist mechanism;

— slew mechanism;

— luff mechanism;

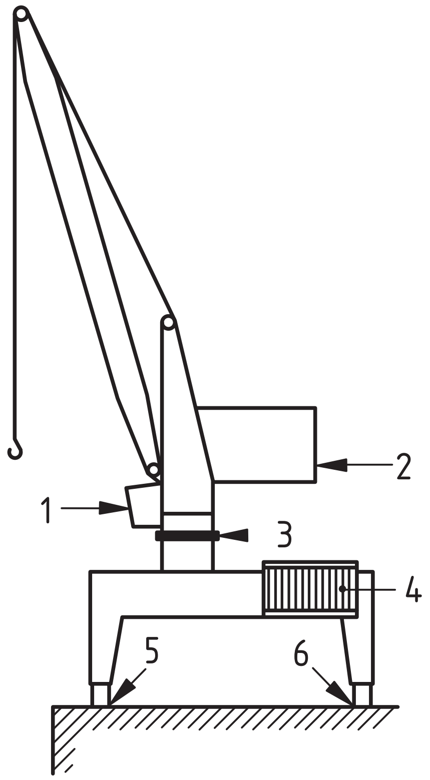
— crane travelling mechanisms;

— fixed load lifting attachment, when power operated.

The values to be used shall include the noise of the electrical control cubicles and power source.

The typical locations of these noise sources are shown in Figure D.1. The operator is assumed to be in a vertical plane containing the sources. For a power operated load lifting attachment the nearest normal operating distance shall be considered.

The values of the A-weighted sound power levels and the distances r used for the calculations shall be reported.



Key

1	operator's cabin	3	slew mechanism
2 to 6	noise sources	4	Diesel generator
2	machinery house	5 and 6	travelling mechanism

Figure D.1 — Typical medium size slewing jib crane indicating noise sources and a single operator position

The conventional A-weighted emission sound pressure level at a certain position under the influence of different sound sources shall be calculated by adding the sound pressure levels from the different sources in accordance with the following equation:

$$L_{pA(total)} = 10\lg\left[\sum_{i=1}^{N} 10^{0,1L_{pAi}}\right]$$

where

$L_{pA(total)}$ is the conventional A-weighted emission sound pressure level i.e. the total A-weighted sound pressure level at the considered position resulting from N sources;

L_{pAi} is the A-weighted sound pressure level resulting from sound source i;

N is the total number of sound sources.

The uncertainty of this calculation is that with which the sound power levels of the components have been determined.

This calculation method does not take into account the effect of structure-borne noise and sound reflection by the ground. The calculated noise levels are usually lower than levels that would be measured. However they provide a useful basis during the crane design stage.

NOTE Example for the addition of two A-weighted sound pressure levels, 70 dB and 72 dB respectively:

$$L_{pA(total)} = 10\lg\left[10^{0,1\times70} + 10^{0,1\times72}\right] = 74,1 \text{ dB}$$

D.4 Emission sound pressure level determination at control stations and other specified positions by measurement

D.4.1 Measurement method and points

Emission sound pressure level measurements shall be made according to EN ISO 11201 at the following positions:

a) The measurements shall be made in or at all control stations;

b) Measurements shall also be taken at minimum and maximum jib radius at a height of 1,6 m above ground level on each working side of the crane; the highest value measured shall be reported and declared together with its position.

This measurement also covers the non-fixed operator positions in the case of radio control and positions specified for very large cranes (see D.4.2).

During measurement of the crane travelling the measuring point shall be kept stationary.

D.4.2 Case of very large cranes

Those cranes that have an A-weighted emission sound pressure level at the operator's position higher than 85 dB are very large cranes. For such cranes, the determination of sound power is replaced by that of emission sound pressure levels on a path at 1 m from the surface of the crane and 1,6 m above the ground. Measurement positions on the path shall be spaced so that the difference in A-weighted emission sound pressure levels between adjacent measuring points does not exceed 5 dB. The number of measuring points will depend on the characteristic of the noise emission. For even distribution of sound pressure levels a low number of measuring points may be necessary. There should, however, be at least one measuring point at each side of the main components of the crane. The measurement positions shall be recorded and reported.

D.4.3 Installation and mounting conditions

The crane shall be installed in its fixed position or on its runway in the condition it is intended to be used, excluding the sound alarm signals which shall be disconnected during the noise measurements.

The mechanisms of the non-fixed load lifting attachments causing noise shall be switched off during the noise measurement cycle.

NOTE Noise caused by the non-fixed load lifting attachments is the matter of the manufacturer of the equipment.

D.4.4 Operating conditions

D.4.4.1 General

In all cases, the testing position of the crane for the measurements shall be so selected that the reflections by nearby obstacles and other environmental disturbances are minimized.

The load handled during the work cycles shall be the rated capacity, but in the case of difficulty in using the rated capacity, a load representing the typical loads and having a mass that is at least 50 % of the rated capacity mass may be used.

Measurements in enclosed cabins shall be taken with the doors and windows closed and the air-conditioning and/or ventilating system(s) operating at midrange speed if more than two operating speeds are available. If only two operating speeds are available, then the highest speed shall be used. If the air-conditioning and/or ventilating systems have a re-circulation and an outside air position control, the control shall be set for outside air.

D.4.4.2 Hoisting, slewing and luffing

The work cycle during measurement should represent the normal practice. If the motions can be operated simultaneously, the working cycle shall be as follows:

a) Hoist the load with maximum speed from alongside the measuring point to half the total lifting height.

b) Start slewing during the remaining hoisting operation.

c) Start luffing before completion of the slewing operation.

d) Start lowering before completion of the luffing operation.

e) Lower the load to the ground.

f) Return the load to the start position in the exact reverse manner.

If there are limitations to prevent simultaneous movements, the above work cycle shall be modified accordingly. Such modifications shall be recorded and reported.

Test cycles and measurements shall be repeated at least three times.

The final test result $\overline{L_{pA1}}$ to be reported and declared is the arithmetic mean value of measured values.

D.4.4.3 Travelling

With travelling cranes, noise measurement during crane travelling shall be made separately holding the load at the mid span of the crane.

The measuring period shall start when the reference box, i.e. a hypothetical surface which is the smallest rectangular parallelepiped that just encloses the sources and terminates on the reflecting plane, reaches the stationary microphone, and it shall end, when the other side of the reference box has passed the microphone.

Test cycles and measurements shall be repeated at least three times.

The test result $\overline{L_{p2}}$ is the arithmetic mean value of the measurements.

D.5 Uncertainties

No technical data on noise emission are presently available to estimate the standard deviation of reproducibility for the family of machinery covered by this noise test code. Therefore, the values of the standard deviation of reproducibility stated in the basic noise emission standard used may be regarded as interim upper boundaries and used for the determination of the uncertainty K when preparing the noise declaration. Investigations requiring a joint effort of manufacturers are necessary to determine a possibly lower value of the standard deviation of reproducibility, which will result in a lower value of the uncertainty K. Results of such investigations will be reflected in a future version of this European Standard.

D.6 Information to be recorded

Measurements shall be recorded according to Clause 12 of EN ISO 11201:2010.

In the calculation method the assumptions made for the calculation, the precise positions of sound sources and operator position(s), the values used as sound power input data and the results of the calculations shall be recorded.

D.7 Information to be reported

The test report shall include the A-weighted emission sound pressure levels and the positions where they were measured or calculated.

The noise values measured during crane travelling shall be reported separately from the values representing the specified work cycle, because such values may be more strongly affected by the noise generated in the runways.

In the calculation method the assumptions made for the calculation, the precise positions of sound sources and operator(s), the values used as sound power input data and the results of the calculations shall be reported.

D.8 Declaration and verification of noise emission values

The declaration and verification of noise emission values shall be made in accordance with EN ISO 4871.

The noise declaration shall be a dual number declaration as defined in EN ISO 4871, i.e. the measured value and the measurement uncertainty shall be indicated separately. It shall give the value of the measured A-weighted emission sound pressure level at the operator and other specified positions where this exceeds 70 dB; where this level does not exceed 70 dB, this fact shall be indicated.

Both values for the work cycle without travelling (see D.4.4.2) and, where the crane is designed to travel, for the travelling of the crane (see D.4.4.3) shall be declared.

The noise declaration shall mention explicitly that noise emission values have been obtained in accordance with this noise test code and indicate the basic standard that has been used, i.e. EN ISO 11201. The noise declaration shall clearly indicate any deviation(s) from this noise test code and/or from the basic standard used.

For very large cranes (see D.4.2), the values on the path around the crane shall also be declared.

When the noise emission values of an individual crane as determined according to D.4 are verified, the measurements shall be conducted by using the same mounting, installation and operating conditions as those used for the initial determination of noise emission values.

Where slewing jib cranes are constructed on site from sub-assemblies, noise emission measurement and the subsequent noise emission declaration shall be made after commissioning.

Annex ZA
(informative)

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

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

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

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

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