



**International
Standard**

ISO 10972-1

**Cranes — Requirements for
mechanisms —**

**Part 1:
General**

*Appareils de levage à charge suspendue — Prescriptions pour les
mécanismes —*

Partie 1: Généralités

**Second edition
2025-02**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 9, *Bridge and gantry cranes*.

This second edition cancels and replaces the first edition (ISO 10972-1:1998), which has been technically revised.

The main changes are as follows:

- in 4.4, the requirement for cranes intended for transportation of molten metals or similar hazardous materials has been moved to a new [Clause 5](#);
- in 4.8, the requirement of rope drives has been revised according to ISO 16625;
- in 4.11, the requirement of load lifting attachment has been revised according to EN 13135:2013+A1:2018;
- a new [Clause 5](#) on high-risk applications has been added.

A list of all parts in the ISO 10972 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document establishes design requirements and guidance that reflect the present state of the art in the field of crane machine design. This document enables cranes to fulfil the essential safety requirements and ensures adequate service of their components. It is acknowledged that new technologies, materials, etc. can bring about new solutions that result in equal or improved safety and durability.

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Cranes — Requirements for mechanisms —

Part 1: General

1 Scope

This document establishes requirements for mechanisms and related components of cranes as described in ISO 4306 series, concerning:

- a) general layout and design of mechanisms;
- b) selection and/or design requirements of components.

This document does not provide requirements for proof of competence calculation regarding different limit states (yield strength, fatigue, wear).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3077, *Short-link chain for lifting purposes — Grade T, (types T, DAT and DT), fine-tolerance hoist chain*

ISO 4301-1, *Cranes — Classification — Part 1: General*

ISO 4306 (all parts), *Cranes — Vocabulary*

ISO 16625, *Cranes and hoists — Selection of wire ropes, drums and sheaves*

ISO 4302, *Cranes — Wind load assessment*

ISO 4310, *Cranes — Test code and procedures*

ISO 4347, *Leaf chains, clevises and sheaves — Dimensions, measuring forces, tensile strengths and dynamic strengths*

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 4779, *Chain components for lifting purposes — Forged eye hook with point and latch — Grade 4, stainless steel, solution annealed*

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

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

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

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

ISO 7752-1, *Cranes — Control layout and characteristics — Part 1: General principles*

ISO 7752-2, *Cranes — Control layout and characteristics — Part 2: Basic arrangement and requirements for mobile cranes*

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

ISO 7597, *Forged steel lifting hooks with latch, grade 8*

ISO 8686 (all parts), *Cranes — Design principles for loads and load combinations*

ISO 10300-1, *Calculation of load capacity of bevel gears — Part 1: Introduction and general influence factors*

ISO 10300-2, *Calculation of load capacity of bevel gears — Part 2: Calculation of surface durability (macropitting)*

ISO 10300-3, *Calculation of load capacity of bevel gears — Part 3: Calculation of tooth root strength*

ISO 12210, *Cranes — Anchoring devices for in-service and out-of-service conditions*

ISO/TS 14521, *Gears — Calculation of load capacity of worm gears*

ISO 17440, *Cranes — General design — Limit states and proof of competence of forged steel hooks*

ISO 20332, *Cranes — Proof of competence of steel structures*

ISO 21940-11, *Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour*

ISO 23778, *Proof of competence of hydraulic cylinders in crane applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the ISO 4306 series and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1

in-service braking

stopping or slowing the crane motion with the motor disconnected, through an immediate and easy control by the operator from the normal working position

3.2

out-of-service braking

avoiding unwanted starts for indefinite periods of time

Note 1 to entry: Actuation may be automatic or manual.

3.3

emergency braking

backup braking

safety braking

stopping the crane motion in case of loss of power or pressure supply through engagement with a limiting device or the activation of an emergency stop switch

3.4

control braking

maintaining a desired speed, automatically or by the operator, with the motor engaged

3.5

chain drive

device for supporting and moving loads via chain and roller arrangement

3.6

rope drive

device for supporting and moving loads via rope, sheave and drum arrangement

4 General

4.1 Design criteria

4.1.1 General design and layout

The general design and layout of a crane mechanism shall take into consideration:

- requirements of the user;
- specific function of the mechanism and its use;
- reliability of the mechanism, considering the consequences of failure;
- displacement of the structure supporting the mechanism;
- avoidance of uncontrolled motions considering the limits of transmission of force or moments, when provided, for example, by motors, clutches, brakes;
- avoidance of undesirable or excessive vibrations;
- avoidance of excessive noise emissions;
- protective measures for rotating parts;
- ease of use and controls of the mechanism with adequate space and motion limiters and indicators;
- recommendations of the component supplier for the selection and installations of component parts;
- serviceability, i.e. easy accessibility for maintenance of components (see ISO 11660-1);
- interchangeability of components;
- availability of lifting lugs or lifting points for handling;
- access for operator or maintenance personnel (see ISO 11660-1);
- environmental conditions and hazards.

4.1.2 Criteria for strength of components

When selecting the components of the mechanisms, it shall be verified that the applicable loading conditions in terms of maximum loading, load spectrum and number of load cycles conform to the corresponding rated characteristics of the components. The loadings shall be in accordance with the ISO 8686 series.

References for the proof of competence calculations may be given for the mechanical components in [4.3](#) to [4.11](#).

4.2 Power

The power mechanism shall be an electrical, hydraulic or pneumatic motor or an internal combustion engine.

The crane mechanism or mechanisms shall have a force and torque equal to or greater than the force and torque values required to properly control the crane under the specified design conditions. Gravitational, inertial, in-service wind, friction forces and mechanism efficiency shall be taken into account.

- a) The average distance per work cycle of each motion (see ISO 4301-1) shall be taken into account, when determining an appropriate rating type of the motor duty and thermal power rating requirement.
- b) The loads to be applied shall be in accordance with the ISO 8686 series, setting all the dynamic factors to $\phi_i = 1$ and the partial safety factors to $\gamma_p = 1$. The hoisted load shall be applied with the value of the rated load, unless otherwise specified. The wind state for an outdoor crane shall be that specified for the crane and applied in calculation of wind forces in accordance with ISO 4302. Travel resistance shall be taken into account as an external load action.

For the thermal capacity calculation, the load combinations A of the ISO 8686 series shall be applied, with the addition of in-service wind force during controlled movement (see ISO 4302) into each load combination.

For the torque calculations, the load combinations B of the ISO 8686 series shall be applied, applying the in-service wind force required for starting drive forces (see ISO 8686-1).

4.3 Couplings

4.3.1 General

The type of coupling shall be selected based on the general design of the mechanism, its use and the performance required in order to avoid vibrations and unwanted reactions. Alignment shall be in accordance with the supplier's instructions.

When necessary, rotating parts shall be statically or dynamically balanced.

4.3.2 Clutches

When sprag-type clutches are used in hoist and derricking systems, they shall incorporate a positive mechanical lock against failure or be designed to transmit twice the maximum torque imposed by the maximum line pull.

Dry friction clutches shall be protected against rain and other liquids such as oil and lubricants. Clutches shall be arranged to permit adjustments where necessary to compensate for wear.

The maximum permissible torque of the clutch shall be at least as high at any operating temperature as the torque impulses occurring during operations, taking into account the impulse frequency and the permissible wear.

4.4 Brakes

4.4.1 General

Braking can be divided into four types: in-service braking, out-of-service braking, emergency braking and control braking.

Means shall be provided for arresting each motion of the crane.

The restraining torque of the brakes shall consider the operating environment.

Emergency braking shall be performed using brakes which are automatically applied in case of power failure. The emergency brakes shall provide a deceleration rate consistent with the design parameters for a fully loaded mechanism.

The force to apply a manual in-service brake by hand or foot shall comply with the requirements of ISO 7752-1, ISO 7752-2 and ISO 7752-4.

The same brake may be used for different types of braking, as appropriate.

4.4.2 Hoist brake

The frictional hoist brakes shall be capable of automatically arresting and sustaining any rated load and dynamic test load at any position within the range of hoisting.

When emergency load-lowering is required, the hoist brake shall be capable of manual release so that control of the load will be maintained during lowering. The emergency load-lowering shall be carried out by special equipment or tools which take into account the heat-dissipating capability of the brake.

The hoist brakes shall be designed to exert a restraining torque of at least 50 % greater than the maximum torque transmitted to the brake from regular loads in accordance with the ISO 8686 series with all dynamic factors ϕ_i and partial safety factors γ_p set to 1.

4.4.3 Travel and slewing brake

Travel and slewing braking shall be capable of arresting the motion of a crane in the most unfavourable loading condition.

4.5 Out-of-service requirements

When the mechanism is not in use, its position shall be retained by means of a brake or locking device. The locking device shall be arranged to avoid inadvertent engagement and disengagement. Engagement of the locking device shall prevent inadvertent operation of the motion. Anchoring devices shall be equipped in accordance with ISO 12210; the out-of-service wind force shall be calculated in accordance with ISO 4302.

When a crane is required to “weather-vane” in the out-of-service mode, the means of controlling this feature shall be operable from the control station. The device shall be activated by a conscious action when the crane is taken out of service.

4.6 Hydraulic and pneumatic systems

4.6.1 General

Crane shall conform to the general requirements presented in ISO 4413 and ISO 4414 for hydraulic and pneumatic systems.

The hydraulic system and the control arrangement shall be such that no combination of control selections can initiate any movement not intended by the operator, unless this is essential for the operation of a safety device or interlock.

The circuits shall incorporate the following safety features:

- relief valves in pressurized hydraulic and pneumatic circuits to limit the maximum pressure in the circuit;
- safety devices to protect against the effects of failure of a hose, pipe or fittings in any load-carrying circuit on the crane.

All components and controls shall be capable of handling the design loads and shall provide safe function of the crane under regular, occasional and exceptional conditions, considering the failure of power source and the testing of the system.

All components and fluids (in a hydraulic system) shall be compatible with the application and the operational environment.

For diagnostic trouble-shooting, pressure test points shall be provided at the appropriate places in the system and be indicated on the circuit diagrams.

Where appropriate, means shall be provided to purge entrapped gas from the hydraulic system.

Back-pressure which can damage or inadvertently control brake components within the system shall be prevented.

Hydraulic cylinders shall be selected or designed based on the maximum compressive and tensile loads at effective length during the characteristic working cycles. Hydraulic cylinders that are part of load carrying structure shall conform to ISO 23778. Consideration shall be made for the available hydraulic pressure and flow, type of fluid, type and material of seals and wipers and bearing size.

The cross-sectional area of the bore of the tubes, hoses, fittings, valves and fluid passages shall be consistent with fluid pressure and flowrates to minimize starvation and undue temperature rise.

The boom-hoisting mechanism shall be provided with an auxiliary ratchet and pawl or other positive locking device to prevent the drum from rotating in the lowering direction, hold the rated loads indefinitely, and be controllable from the operator's station.

4.6.2 Hydraulic reservoir

The hydraulic reservoir shall maintain the fluid level with a safe margin on the working height during operation and should be capable of containing all the fluid that can flow back from the system with cylinders in the closed position and hold a sufficient reserve of fluid to assist in cooling the hydraulic oil temperature within the limits specified by the supplier.

4.6.3 Filters

The system shall incorporate filters for continuous removal of contaminants from the hydraulic fluid or the air supply.

Filters should be selected and installed so that the filter medium can be changed without disturbing the piping arrangement and draining the fluid from the reservoir. Where brakes are held off hydraulically, filters shall not be placed in the brake return circuit, as they can block and cause sufficient back-pressure to hold off a brake.

Filters should be selected and installed so that the filter medium can be changed without disturbing the pneumatic tubing.

4.6.4 Installation

The installation of the system shall be such that the effects of external influences (e.g. atmospheric conditions, unauthorized interference and mechanical impact) shall not be detrimental to the system. In addition, installation-induced stresses in tubes shall be avoided and flexibility of the support members shall be allowed for on all rigid tubes.

The inclusion of contaminants shall be avoided during assembly and installation of components, and the system should be thoroughly cleaned prior to testing.

The specific type of hydraulic fluid in the system shall be either permanently and legibly marked at the point of filling of the reservoir or included in the instruction manuals. Other hydraulic fluids shall not be used, either alone or mixed with the specified fluid.

On each accumulator, the pre-charge pressure and charging medium shall be permanently and legibly marked.

4.7 Gear drives

4.7.1 Strength requirements

In any operating condition, the following requirements shall be met:

- non-permissible stresses from elastic and/or thermal deformations shall be avoided;

- statically determined configurations and components shall be preferred so that the stresses occurring are known and their effects on other components can be determined.

4.7.2 Gears

The proof of static and fatigue strength for cylindrical (i.e. spur and helical) gears shall be in accordance with:

- ISO 6336-1 for basic principles and general influence factors;
- ISO 6336-2 for the calculation of surface durability (pitting);
- ISO 6336-3 for the calculation of tooth bending strength;
- ISO 6336-5 for the strength and quality of materials.

The proof of static and fatigue strength for bevel gears shall be in accordance with:

- ISO 10300-1 for general influence factors;
- ISO 10300-2 for the calculation of surface durability (pitting);
- ISO 10300-3 for the calculation of tooth root strength.

The proof of static and fatigue strength for worm gears shall be demonstrated using ISO/TS 14521.

Gear wheels shall be made from a material that has proven properties for the intended application and life of the gear. The dimensions of the gears shall be derived from the rated torque, material strength and the driving gear groups. The type of connection shall not produce any non-permissible stresses on the gears.

Irreversibility shall be avoided where the moment of inertia of the moved parts is greater than the moment of inertia of the moving parts.

Open gears should not be used for environments with serious dust pollution.

4.7.3 Gear enclosures

Gearing shall be guarded when it constitutes a hazard during normal operation or maintenance.

Where gears are fully enclosed in a gearbox, the gearbox shall be oil-tight and sealed with a gasket or an appropriate sealing compound.

The gearbox supporting structure shall firmly secure the gearbox in position and prevent it from coming loose during operation.

The gearbox construction shall be rigid to ensure that the gear shaft alignments and centre distances are maintained under all working conditions.

Drain plugs, breathers and oil-level indicators should be readily accessible. Gearboxes should be provided with lifting lugs.

Attention shall be paid to ensure lubrication of all gears and bearings.

4.7.4 Bearings and supports

For a component supported on a bearing, the bearing itself and its support structure shall be designed so that failure of a bearing shall not lead to the dropping of any major part of the crane or the load.

4.8 Rope drive requirements

4.8.1 General

Rope drives shall be classified into driving-gear groups in accordance with the operating requirements and conditions of use of the hoisting gear in accordance with ISO 4301-1.

Calculations for rope drives shall be made in accordance with ISO 16625.

Design of rope drives shall take into account possible uneven distribution of load between the ropes, if these are not eliminated by design.

Rope equalizers shall be arranged to permit movement of the rope at the rope equalizer without sliding movement between the rope and equalizer.

4.8.2 Drums

Drums shall be made from a material that has proven properties for the intended application and life of the drum. The pitch diameter of the drum shall be in accordance with ISO 16625.

Where it is not practicable to accommodate all the ropes in a single layer, a special provision shall be made to ensure the correct coiling of the rope from each layer to the next (spooling aids, where necessary) under any condition of operation.

The drum shall be designed such that at the outer limit position a length of rope more than two drum revolutions remains attached. At the inner limit position of a single layer drum, a length of groove equivalent to at least one complete revolution of the drum shall remain unoccupied.

The thickness of the drum shell shall be determined by proof of competence calculation or by tests. If not covered by calculation or tests, a wear allowance shall be added to the drum thickness. The wear allowance shall take into account factors such as material hardness, environment and intended service conditions.

Rope drums shall be designed so that the ropes cannot run off the end of the drum.

Suitable measures for single-layer drums are flanges, rope guides with end limiters or other end limitations that prevent the rope jamming. The flanges and other side limitations shall be flat and extend not less than 1,5 times the rope diameter beyond the outmost rope layer.

The multi-layered drums shall be provided with a flange at least at each point where the rope enters the next layer. The drum flanges should project above the last layer of rope by a minimum of 0,5 times the nominal rope diameter.

For optimal rope life conditions, the groove design should follow the recommendations of ISO 16625.

Grooving shall be smooth and free from surface defects liable to damage the rope. The edges shall be rounded.

Where a rope drum requires balancing, the provisions of ISO 21940-11 shall be applied.

Other recommendations for drum design are given in ISO 16625.

Rope anchorage shall be secure and readily accessible. If two or more ropes lead off a drum, a provision shall be made for the adjustment of the rope length at an anchored end.

Recommendations for rope anchorage on drum are given in ISO 16625.

4.8.3 Sheaves

Sheaves shall be made from a material that has proven properties which are known for the intended application and life of the sheave.

The pitch diameter of the sheaves shall be in accordance with ISO 16625.

For optimal rope life conditions, the groove design of sheave should follow the recommendations of ISO 16625.

Rope sheaves shall have protection against the ropes jumping out of the grooves (e.g. in the case of a slack rope). The distance between the edge of the sheaves and the protective means shall not exceed $\frac{1}{3}$ of the rope diameter or 8 mm, whichever value is the smaller.

All sheave bearings shall be equipped with means for lubrication. Otherwise, permanently-lubricated sealed bearings are acceptable.

4.8.4 Ropes

The steel wire ropes shall be selected in accordance with ISO 16625. The steel wire ropes and the rope terminations shall conform to the requirements of ISO 16625.

The high-performance fibre ropes should be selected according to either ISO/TS 23624 or the fibre rope manufacturer requirements. The high-performance fibre ropes and rope terminations should conform to the requirements of ISO/TS 23624.

4.9 Chain drive requirements

4.9.1 General

Chain drives shall be classified into driving-gear groups in accordance with the operating requirements and conditions of use of the hoisting gear as specified in ISO 4301-1.

Chain-drive wheels and reversing wheels shall be designed so that the chains are not overstressed by bending.

Chain-drive wheels, chain-reversing wheels, chain guides and the chains shall all be matched to each other with regard to dimensions and materials.

Chain-drive wheels shall be of a monobloc design.

All parts of the chain drive shall be protected against thermal radiation, if necessary.

4.9.2 Chains

Round steel link chains shall be selected, manufactured, tested, marked and used in accordance with ISO 3077.

Roller chains shall be manufactured, tested and marked in accordance with ISO 4347. The ratio of the ultimate breaking force to the design force of the roller chains shall be at least 4 in the case of hand-powered hoisting gear and at least 5 in the case of powered hoisting gear.

4.9.3 Chain guides

Chain drives shall have a device to ensure the correct running of the chain over the chain-drive wheels and chain-reversing wheels and to prevent the chain from jumping out, twisting and jamming.

In working and traffic zones of chain drives, the engagement points of the chain on the chain wheels shall be safeguarded to prevent personnel from contact.

4.9.4 Chain mountings

Chain mountings shall be dimensioned so that 2,5 times the nominal force in the chain can be absorbed without permanent deformation. In addition for hoists, proof shall be provided of the required fatigue strength.

The unloaded chain end shall be secured so that it cannot be pulled through. This protective device shall be capable of reliably absorbing the forces to be expected.

Screwed connections in chain mountings shall be secured against accidentally becoming undone. It shall be possible to check the condition of the fastening.

4.10 Shafts

Shafts shall be designed to resist all stresses due to bending and torsion or a combination of both and stress reversal and stress raising elements shall be taken into account, e.g. keyways, splines, section changes. Their loadings shall be in accordance with the ISO 8686 series and their number of stress cycles (proof of fatigue strength) calculated from ISO 4301-1.

4.11 Load lifting attachment requirements

4.11.1 General

The fixed load lifting attachment shall be dimensioned for the maximum rated load. The design, material and manufacture of the fixed load lifting attachment shall be such that fatigue fractures and brittle fractures are avoided.

In general, the stress history classification (S) of the fixed load lifting attachment shall conform to the usage parameters (C, Q, P) specified for the crane in accordance with ISO 4301-1.

Hook assemblies shall be weighted to ensure that they descend under all designed operating conditions.

Measures shall be taken to prevent unintentional release of the load due to grounding or impact. The backup battery for a load handling magnet shall be able to hold the load for at least 20 min after the loss of the power supply.

When selecting the materials, the work environment effects shall be taken into account, e.g. temperatures, thermal radiation when transporting hot molten materials.

4.11.2 Hooks

Means shall be provided to prevent the unintentional detachment of the load, unless this is avoided by the application. Where a hook is provided with a safety latch, the latch shall be self-closing and bridge the throat of the hook for the purpose of retaining slings, chains, etc. under slack conditions.

Forged hooks shall be in accordance with ISO 17440.

Hooks for use in chain slings shall conform to ISO 4779 or ISO 7597. Verification shall be made that no permanent deformation of the hook has taken place during testing in accordance with ISO 4310.

A plate hook can have one or several plate elements. These shall be cut from a steel plate so that the rolling direction of the plate is parallel with the loading direction of the hook. The inner edge of plate elements shall be finished smooth after cutting by machining or grinding. Plate elements in a multiplate hook should all be of equal thickness and of equal shape and shall be connected by riveting.

Load capacity of a plate hook shall be determined in accordance with ISO 20332. Evaluation of stresses shall be done either analytically (by applying curved beam bending theory in accordance with ISO 17440 or by means of finite element modelling) or experimentally by measurement.