
**Safety of amusement rides and
amusement devices —**

**Part 1:
Design and manufacture**

Sécurité des manèges et des dispositifs de divertissement —

Partie 1: Conception et fabrication
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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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 254, *Safety of amusement rides and amusement devices*.

ISO 17842 consists of the following parts, under the general title *Safety of amusement rides and amusement devices*:

- *Part 1: Design and manufacture*
- *Part 2: Operation and use*
- *Part 3: Requirements for inspection during design, manufacture, operation and use*

Safety of amusement rides and amusement devices —

Part 1: Design and manufacture

1 Scope

This part of ISO 17842 specifies the minimum requirements necessary to ensure the safe design, calculation, manufacture, and installation of the following: mobile, temporary or permanently installed machinery and structures, e.g. roundabouts, swings, boats, Ferris wheels, roller coasters, chutes, grandstands, membrane or textile structures, booths, stages, side shows, and structures for artistic aerial displays. The above items, hereafter called *amusement devices* or simply “devices”, are intended to be installed both repeatedly without degradation or loss of integrity, and temporarily or permanently in fairgrounds and amusement parks or any other locations. Fixed grandstands, construction site installations, scaffolding, removable agricultural structures and simple coin operated children’s amusement devices intended for up to 3 children are not covered by this document.

Nevertheless this document can be used in the design of any similar structural or passenger-carrying device not explicitly mentioned herein.

Existing national rules on workers’ safety are not concerned by this document.

This document is applicable to amusement devices and major modifications of amusement devices and rides manufactured after the effective date of its publication.

ISO 17842-3 contains requirements for inspection during design, manufacture, operation and use.

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 288-9, *Specification and approval of welding procedures for metallic materials — Part 9: Welding procedure test for pipeline welding on land and offshore site butt welding of transmission pipelines*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 1141, *Fibre ropes — Polyester — 3-, 4-, 8- and 12-strand ropes*

ISO 1181, *Fibre ropes — Manila and sisal — 3-, 4- and 8-strand ropes*

ISO 1346, *Fibre ropes — Polypropylene split film, monofilament and multifilament (PP2) and polypropylene high-tenacity multifilament (PP3) — 3-, 4-, 8- and 12-strand ropes*

ISO 2307, *Fibre ropes — Determination of certain physical and mechanical properties*

ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements*

ISO 3834-3, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements*

ISO 4014, *Hexagon head bolts — Product grades A and B*

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- ISO 4016, *Hexagon head bolts — Product grade C*
- ISO 4017, *Fasteners — Hexagon head screws — Product grades A and B*
- ISO 4018, *Hexagon head screws — Product grade C*
- ISO 4032, *Hexagon regular nuts (style 1) — Product grades A and B*
- ISO 4034, *Hexagon regular nuts (style 1) — Product grade C*
- 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 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*
- ISO 7250 (all parts), *Basic human body measurements for technological design*
- ISO 9554, *Fibre ropes — General specifications*
- ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*
- ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*
- ISO 9692-1, *Welding and allied processes — Types of joint preparation — Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels*
- ISO 9692-2, *Welding and allied processes — Joint preparation — Part 2: Submerged arc welding of steels*
- ISO 9712:2012, *Non-destructive testing — Qualification and certification of NDT personnel*
- ISO 10042:2005, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections. Corrected by ISO 10042:2005/Cor. 1:2006*
- ISO 10325, *Fibre ropes — High modulus polyethylene — 8-strand braided ropes, 12-strand braided ropes and covered ropes*
- ISO 10474:2013, *Steel and steel products — Inspection documents*
- ISO 10547, *Polyester fibre ropes — Double braid construction*
- ISO 10554, *Polyamide fibre ropes — Double braid construction*
- ISO 10556, *Fibre ropes of polyester/polyolefin dual fibres*
- ISO 10572, *Mixed polyolefin fibre ropes*
- ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*
- ISO 13849-2, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*
- ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 14118, *Safety of machinery — Prevention of unexpected start-up*
- ISO 14119, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

- ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*
- ISO 14122-1, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels*
- ISO 14731, *Welding coordination — Tasks and responsibilities*
- ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*
- ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*
- ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*
- ISO 15610, *Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables*
- ISO 15611, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience*
- ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure*
- ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test*
- ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*
- ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys*
- ISO/IEC 17020, *Conformity assessment — Requirements for the operation of various types of bodies performing inspection*
- ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*
- ISO 17635, *Non-destructive testing of welds — General rules for metallic materials*
- ISO 17636-1:2013, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film*
- ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*
- ISO 17638, *Non-destructive testing of welds — Magnetic particle testing*
- ISO 17640:2010, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment*
- ISO/TS 17929:2014, *Biomechanical effects on amusement ride passengers*
- ISO 23277, *Non-destructive examination of welds — Penetrant testing of welds — Acceptance levels*
- ISO 23278, *Non-destructive examination of welds — Magnetic particle testing of welds — Acceptance levels*
- ISO 23279, *Non-destructive testing of welds — Ultrasonic testing — Characterization of indications in welds*
- IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*
- IEC 60204-32, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines*

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IEC 60364-4-41, *Electrical installations of buildings — Part 4-41: Protection for safety — Protection against electric shock*

IEC 60364-5-54, *Electrical Installation of buildings — Part 5-54: Selection and erection of electrical equipment — Chapter 54: Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60364-7-740, *Electrical Installation of buildings — Part 7-740: Selection and erection of electrical equipment — Chapter 54: Requirements for special installations or locations Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses*

IEC 61558-1, *Safety for transformers, power supply units and similar devices*

IEC 61800-5-2, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC 62305 (all parts), *Protection against lightning*

EN 485, *Aluminium and aluminium alloys — Sheet, strip and plate*

EN 755, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles*

EN 818 (all parts), *Short link chain for lifting purposes*

EN 1069-1, *Water slides — Part 1: Safety requirements and test methods*

EN 1176 (all parts), *Playground equipment and surfacing*

EN 1261, *Fibre ropes for general service — Hemp*

EN 1677, *Components for slings — Safety*

EN 1991-1-4:2005, *Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions*

EN 1992-1-1, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1993-1-1, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1993-1-8, *Eurocode 3: Design of steel structures — Part 1-8: Design of joints*

EN 1993-1-9:2005, *Eurocode 3: Design of steel structures — Part 1-9: Fatigue*

EN 1995-1-1, *Eurocode 5 — Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

EN 1999-1-1, *Eurocode 9: Design of aluminium structures - Part 1-1: General structural rules*

EN 10025-1, *Hot rolled products of structural steels — Part 1: General technical delivery conditions*

EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weld able fine grain structural steels*

EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*

EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10210, *Hot finished structural hollow sections of non-alloy and fine grain steels (all parts)*

EN 10219, *Cold formed welded structural hollow sections of non-alloy and fine grain steels (all parts)*

EN 12385 (all parts), *Steel wire ropes — Safety*

EN 13411 (all parts), *Terminations for steel wire ropes — Safety*

EN 13889, *Forged steel shackles for general lifting purposes — Dee shackles and bow shackles — Grade 6 — Safety*

EN 14399 (all parts), *High-strength structural bolting assemblies for preloading*

EN 50172, *Emergency escape lighting systems*

ASME *Boiler and Pressure Vessel Code (BPVC)*. American Society of Mechanical Engineers

EEC/2009/105/EC, *DIRECTIVE 2009/105/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 relating to simple pressure vessels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17842-2, ISO 17842-3, ISO/IEC 17020 and ISO/TS 17929, and the following apply.

NOTE Any symbols connected with the respective terms or units are explained in the clauses concerned.

3.1

amusement device

arrangement of equipment that produces the desired effect of amusement or entertainment when the *patron* (3.25) moves through it or on it primarily by his or her own action, or any other system that is not covered by the term *amusement ride* (3.2)

Note 1 to entry: In this document, the word “device” is used to refer to an amusement device or *amusement ride* (3.2).

3.2

amusement ride

equipment that is designed to entertain the *passengers* (3.25) during motion including biomechanical effects

Note 1 to entry: In this document, the word “device” is used to refer to an *amusement device* (3.1) or amusement ride.

Note 2 to entry: See ISO/TS 17929 for the definition of biomechanical effect.

3.3

attendant

competent person (3.6) appointed to work under the supervision of an *operator* (3.23), to assist in the operation of a device available for use by the public

3.4

clearance envelope

patron clearance envelope

passenger clearance envelope

reach envelope plus a suitable margin as defined in [Annex I](#)

3.5

closed

<restraint>position in which the *restraint* (3.31) is intended to remain during the operation of the device in order to restrain the *passenger* (3.25)

3.6

competent person

person who has acquired through training, qualifications or experience, or a combination of these, the knowledge and skills enabling that person to perform a specified task

3.7

controller

<ride> person or organization having overall control of a device

Note 1 to entry: This may be either an individual or corporate body owning a device or the concessionaire or lessee who has been granted control of the device, by the owner, for a specified period.

3.8

designer engineer

person or body responsible for the design of a device (or modifications thereof), including, but not limited to, establishing and describing the configuration of the amusement ride or device, conducting appropriate risk assessment(s), establishing strength (including fatigue strength), designing and specifying electrical/electronic control systems, defining inspection criteria and including the provision of the necessary documentation

3.9

design review

document detailing the review of all the applicable design documents, to determine the suitability for use of a device

3.10

design risk assessment

DRA

document produced by the *designer* (3.8) to ensure a safe design within the agreed scope of supply

3.11

device log

book or file containing all the necessary information about the use and history of any device

3.12

fail safe

characteristic of a system, component or device the failure of which results in a safe state

3.13

fence

structure designed to restrict or prevent movement across a boundary

3.14

gate

section of fencing or barrier that may be opened to provide access

3.15

guest

person who interacts with a device

Note 1 to entry: While both are guests, a *passenger* (3.25) is active and a *spectator* (3.39) is passive.

3.16

inspection body

any organization operating in accordance with ISO/IEC 17020 carrying out approval, examination and tests of devices

3.17

initial approval

design and calculation review, verification, examinations and tests executed by the inspecting body before a device is first made available for public use

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3.18 latching

<restraint> means of being held secure against opening except by intentional action of the *passenger* (3.25), *operator* (3.23) or other means

Note 1 to entry: This can include *restraints* (e.g. drop bars) (3.31) held in place by gravity, detents or other means.

3.19 licensing body

any national authorities or bodies legally authorized to issue a permit for operation of a device and related documents

3.20 locking

means by which a locked *restraint* (3.31) is held secure against opening except by intentional action of the *operator* (3.23) or other means not accessible by the *passenger* (3.25)

3.21 manufacturer

any natural or legal person who is responsible for designing and manufacturing a product with the view to placing it on the market under his own name

Note 1 to entry: Any commercial operator that either places a product on the market under his own name or trademark or modifies a product in such a way that compliance with applicable requirements maybe affected should be considered to be the manufacturer and should assume the obligations of the manufacturer.

3.22 major modification

safety-related alteration to the hardware or software of a device, including the introduction of a new *safety-related component* (3.36) or the substitution of a safety-related component, which results in a deviation from the design specification [ISO 17842-1:2015](https://standards.iso.org/iso/17842-1:2015)

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3.23 operator

person appointed by the *controller* (3.7) to be in charge of the operation of a device at all times when it is intended to be available for the public

3.24 operation and use risk assessment OURA

document, produced by the controller, that details all of the considered risks inherent during all modes of device operation at the particular location and the means taken to mitigate against them

3.25 passenger patron

any person using a device

3.26 passenger containment

components (e.g. seating, foot wells, handrails, passenger restraints) designed to prevent *passengers* (3.25) from moving outside a predetermined area on a ride either as a result of biomechanical effects, the ride forces or the behaviour of the passenger

3.27 passenger unit PU

part or parts of a device in or on which the *passengers* (3.25) are intended to ride

3.28

passenger safety envelope
safety envelope

motion safety envelope

passenger clearance envelope

theoretical or actual physical space that may be encroached upon by any part of a *passenger* (3.25) of an amusement ride during the ride cycle

3.29

permit

authorization to operate a device granted by the licensing body after successful approval or examination

3.30

platform

horizontal or slightly inclined surface raised above the level of an adjacent area

3.31

restraint

system, device, or characteristic that is intended to inhibit or restrict the body movement and/or maintain the body position to tolerate accelerations of the *patron(s)* (3.25) while on the device

3.32

reach envelope

patron reach envelope

passenger reach envelope

physical space where a passenger could reach during a ride cycle while properly positioned, as defined by the ride analysis, in the device and limited only by the vehicle, seat geometry, and restraint system

3.33

repair

restoration of *safety-related components* (3.36) or assemblies to the requirement set out in the manual

3.34

reasonably foreseeable misuse

<human error>use of a machine in a way not intended by the *designer* (3.8), but which can result from readily predictable human behaviour

[SOURCE: ISO 12100:2010, 3.24.]

Note 1 to entry: [Annex G](#) gives a non-exhaustive list of guest behaviour.

3.35

safe stop

stop of an *amusement ride* (3.2) in a safe way and in a final safe position

3.36

safety-related component

component of a device on which the safety of the *passengers* (3.25) is dependent

3.37

service

replacement or replenishment of components, including fluids which are designated to be replaced or replenished at specified intervals

3.38

sideshow

booth or similar enclosed structure containing shows, activities or games for the entertainment of the public, where the *guest* (3.15) is not carried in any way by the structure

3.39**spectator**

person in the vicinity of a device, typically watching the operation of the device or waiting to gain access to the use the device

3.40**SRCS****safety-related control system**

assembly of components that may be electronic, electric, electro-mechanical, hydraulic, pneumatic or mechanical combined to monitor and control a device so as to reduce risks to guests

3.41**sustained acceleration**

acceleration with duration greater than or equal to 200 ms

3.42**temporarily installed device**

device which is designed to be mounted and demounted with an installation period not more than 3 months

3.43**trial run**

proving run of a device during which no *passengers* (3.23) are carried

4 Requirements for design analysis and examination

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4.1 Design documents**4.1.1 General**

ISO 17842-1:2015

The construction documents include all the documents required for the assessment of the stability and operational safety of the device, including the Design Risk assessment (DRA). They shall be available for any subsequent approval by the inspection bodies. These documents shall encompass all the design conditions pertaining to the operation of the devices or structures. A description of the construction, operation and operational safety, design drawings and a comprehensive stress, fatigue and stability analysis as specified in 5.1.4 are required for this purpose.

4.1.2 Design risk assessment

See 5.1.2.1.

4.1.3 Description of design and operation

The device, in particular its design, modes of operation and its structure shall be explained in this description. Adequate details of mechanical (hydraulic, pneumatic), electrical and electronic equipment, including the control system shall be listed. The description shall include details of the particular features of the device and of any alternative modes of installation which may exist. Also details of the main dimension and of motion spaces extending beyond these dimensions, limitations, design particulars and materials, motion systems, types of drive, velocities, accelerations, electrical equipment, work cycle and operating sequence and of any restrictions regarding the circle of users which may exist, shall be described.

4.1.4 Design and manufacturing drawings

These are required for all assemblies, subassemblies and individual components, the fracture or failure of which might endanger the stability or operational safety of the device. The drawings shall feature all the dimensions and cross-section values required for testing and approval, including details of materials, structural components, fasteners, connectors, and also relevant velocities.