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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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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 254, *Safety of amusement rides and amusement devices*.

This second edition cancels and replaces the first edition (ISO 17842-1:2015), which has been technically revised.

The main changes are as follows:

— the normative references have been updated;

— the terms and definitions have been revised;

— alignment with EN 13814 series from 2019;

— the general risk assessment has been supplemented by the operator-side risk assessment;

— the safety distances of passenger units have been fundamentally revised;

— the requirements for personal restraint systems have been supplemented by additional monitoring;

— new Annex I contains the acceleration effects on passengers to align with ASTM F2291-21.

A list of all parts in the ISO 17842 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.

Safety of amusement rides and amusement devices —

Part 1:
Design and manufacture

1 Scope

This document specifies the minimum requirements necessary to ensure the safe design, calculation, manufacture and installation of mobile, temporary or permanently installed amusement ride machinery and structures, which are intended for use by persons as a leisure activity. The amusement rides and amusement devices include for example, roundabouts, swings, boats, Ferris wheels, roller coasters, chutes, booths, side shows and structures for artistic aerial displays. They 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.

This document is not applicable to grandstands, construction site installations, scaffolding, removable agricultural structures, simple coin operated children's amusement devices, carrying up to three children, and recreational devices like waterslides or summer toboggan runs, playground equipment, rope courses, climbing wall, inflatable, trampolines, swimming pool equipment, etc.

NOTE For all the equipment not covered by the requirements of ISO 17842-1, the relevant standards apply.

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

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 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 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

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

ISO 3834-4, *Quality requirements for fusion welding of metallic materials — Part 4: Elementary quality requirements*

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

ISO 4016, *Fasteners — Hexagon head bolts — Product grade C*

ISO 4017, *Fasteners — Hexagon head screws — Product grades A and B*

ISO 4018, *Fasteners — Hexagon head screws — Product grade C*

ISO 4032, *Fasteners — Hexagon regular nuts (style 1)*

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, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

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 9692-3, *Welding and allied processes — Types of joint preparation — Part 3: Metal inert gas welding and tungsten inert gas welding of aluminium and its alloys*

ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections*

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

ISO 13854:2017, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

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, *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 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 17635:2016, *Non-destructive testing of welds — General rules for metallic materials*

ISO 17842-2:2022, *Safety of amusement rides and amusement devices — Part 2: Operation and use*

ISO 17842-3, *Safety of amusement rides and amusement devices — Part 3: Requirements for inspection during design, manufacture, operation and use*

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*

IEC 60364-4-41, *Low-voltage electrical installations — 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 — Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60364-7-740, *Electrical Installation of buildings — Part 7-740: 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 of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests*

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

EN 1069-1+A1, *Water slides — Part 1: Safety requirements and test methods*

EN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1090-3, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

EN 1090-3:2008, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

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

EN 1677 (all parts), *Components for slings — Safety*

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

EN 12195-2, *Load restraint assemblies on road vehicles — Safety — Part 2: Web lashing made from man-made fibres*

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

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

EN 13889+A1, *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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
amusement device
arrangement of equipment that produces the desired effect of amusement or entertainment when the *patron* (3.26) 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 term "amusement device" is used to refer to an amusement device or *amusement ride* (3.2).

3.2
amusement ride
device that is designed to entertain the *passengers* (3.26) during motion including the consequence of biomechanical effect

Note 1 to entry: In this document, the term "amusement 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* (3.25), to assist in the operation of a device available for use by the public

3.4
barrier
device intended to prevent the user from falling and from passing beneath a barrier

Note 1 to entry: A barrier can also be used as a fence.

3.5
closed restraint
restraint in a position in which the *restraint* (3.35) is intended to remain during the operation of the amusement device in order to restrain the *passenger* (3.26)

3.6
competent person
person who can demonstrate the knowledge and skills acquired through training, qualifications or experience, or a combination of all, enabling that person to perform a specified task

3.7
controller
person or organisation having overall control of an *amusement device* (3.1)

Note 1 to entry: This may be either an individual or corporate body owning an *amusement device* (3.1) or the concessionaire or lessee who has been granted control of the amusement device, by the owner, for a specified period.

3.8
design review
document detailing the review of all the applicable design documents to determine the suitability for use of an *amusement device* (3.1)

3.9
design risk assessment
DRA
document produced by the *designer* (3.10) as a tool to ensure a safe design within the agreed scope of supply

3.10
designer
engineer
person or body responsible for the design of an *amusement device* (3.1) (or modifications thereof), including, but not limited to, establishing and describing the configuration of the *amusement ride* (3.2) or *amusement device* (3.1), conducting appropriate risk assessment(s), establishing strength (including fatigue strength), designing and specifying electrical/electronic control systems, defining the acceptable quality level for production, defining inspection criteria and including the provision of the necessary documentation

3.11
amusement device log
book and/or electronic data file containing all the necessary information about the use and history of any *amusement device* (3.1)

3.12
fail safe
characteristic of a system, component or device the failure of which maintains a safe state

3.13
fence
structure designed to restrict or prevent movement across a boundary without change of elevation

3.14
gate
section of *fence* (3.13) or *barrier* (3.4) that can be opened to provide access or egress

3.15
guardrail
rail intended to prevent a user from falling

3.16
guest
person who interacts with an *amusement device* (3.1)

3.17
handrail
rail intended to assist the user to balance

3.18
initial approval
design and calculation review process, including verification, examinations and tests executed by the inspecting body before an *amusement ride* (3.2) is first made available for public use

3.19
latching restraint
restraint (3.35) which is held secure against opening except by intentional action of the *passenger* (3.26) or the *operator* (3.25)

Note 1 to entry: This can include *restraints* (3.35) (e.g. drop bars) held in place by gravity, detents or other means.

3.20
locking restraint
restraint (3.35) which is held secure against opening except by intentional action of the *operator* (3.25) or other means not accessible by the *passenger* (3.26)

3.21
machinery component
component which forms part of an assembly in which at least one component moves (excluding vibration and deformation)

3.22
major modification
safety-related alteration to the hardware or software of an *amusement device* (3.1), including the introduction of a new *safety-related component* (3.39) or the substitution of a *safety-related component* (3.39), which results in a deviation from the current design specification

3.23
manufacturer
individual or commercial entity responsible for a product with the view to placing it on the market under his/her own name

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

3.24
operation and use risk assessment
OURA
document produced by the *controller* (3.7) that details all of the considered risks inherent during all modes of *amusement device* (3.1) operation and the means taken to mitigate against them

Note 1 to entry: This term is explained in detail in 5.1.2.2.

3.25
operator
competent person appointed by the *controller* (3.7) to be in charge of the operation of an *amusement device* (3.1) when it is available to the public

3.26
passenger
patron
person using an *amusement device* (3.1)

3.27
passenger containment
components (e.g. seating, foot wells, handrails, passenger restraints) designed to prevent *passengers* (3.26) from moving outside a predetermined area on a ride either as a result of biomechanical effects, the ride forces or the reasonably foreseeable behaviour of the *passenger* (3.26)

3.28
passenger reach envelope
reach envelope
physical space around a *passenger* (3.26) during a ride cycle while properly positioned, as defined by the ride analysis, in the *amusement ride* (3.2) or *amusement device* (3.1) and limited only by the vehicle, seat geometry and restraint system

3.29
passenger unit
PU
part or parts of an *amusement ride* (3.2) in or on which the *passengers* (3.26) are intended to ride

3.30
permit
authorization to operate an *amusement device* (3.1) in a particular state granted by the legally authorized body after successful approval and/or examination

3.31
platform
horizontal or slightly inclined surface raised above the level of an adjacent area

3.32
reasonably foreseeable misuse
use of an *amusement device* (3.1) in a way not intended by the *designer* (3.10), but which can result from readily predictable human behaviour

Note 1 to entry: Annex F gives a non-exhaustive list of guest behaviour.

[SOURCE: ISO 12100:2010, 3.24, modified — "machine" has been replaced with "amusement device", Note 1 to entry has been added.]

3.33
redundancy
application of more than one device or system, or part of a device or system, with the objective of ensuring that in the event of one failing to perform its function, another will perform that function

3.34
repair
restoration of components or assemblies to a technically acceptable condition

Note 1 to entry: See also ISO 17842-2:2022, 4.3.8.3.

3.35
restraint
system, device, or characteristic that is intended to inhibit or restrict the body movement and/or maintain the body position to allow the *passenger* (3.26) to tolerate accelerations while on the *amusement ride* (3.2) or *amusement device* (3.1)

3.36
safe stop
stop of an *amusement ride* (3.2) in a safe way and in a final safe stable position

3.37
safety envelope
clearance envelope
area in which *passengers* (3.26) are prevented from being injured while moving in an *amusement ride* (3.2) or *amusement device* (3.1)

Note 1 to entry: This is the *passenger reach envelope* (3.28) plus a suitable margin as defined in Annex H.

3.38
safety-related control system
SRCS
assembly of components that can be electronic, electric, electro-mechanical, hydraulic, pneumatic or mechanical combined to monitor and control a device so as to reduce risks to *guests* (3.15)

3.39
safety-related component
component of an *amusement device* (3.1) on which the safety of the *passengers* (3.26) is dependent as identified in the *design risk assessment* (3.9) and/or the *operation and use risk assessment* (3.24)

3.40
service
replacement or replenishment and check of conditions of components, including fluids which are designated to be replaced or replenished and/or checked at specified intervals

3.41
sideshow
booth or similar enclosed structure containing shows, activities or games for the entertainment of the public, where the *guest* (3.15) is not transported in any way by the structure

3.42
spectator
person in the vicinity of an *amusement device* (3.1), either watching the operation of the *amusement device* (3.1) or waiting to access to the use the *amusement device* (3.1)

3.43
structural component
calculated load bearing part which has not been classified as *machinery components* (3.21) by the *designer* (3.10)

3.44
sustained acceleration
acceleration with duration greater than or equal to 200 ms

Note 1 to entry: See Annex I.

3.45
temporarily installed amusement device
amusement device (3.1) designed to be installed and uninstalled and whose installation period does not exceed more than three months

3.46
thorough examination
procedures and investigations necessary for the inspection body to decide whether the *amusement device* (3.1) can continue to be operated safely or whether it requires defects to be remedied immediately or within a specified time

3.47
trial run
proving run of an *amusement device* (3.1) during which no *passengers* (3.26) are carried

4 Requirements for design analysis and examination

4.1 Design documents

4.1.1 General

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 amusement 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 of an amusement device

The amusement 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

Design and manufacturing drawings are required for all assemblies, subassemblies and individual components, the fracture or failure of which can endanger the stability or operational safety of the amusement 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.

The drawings shall include as a minimum, as applicable:

— general drawings in plan view, elevation and sections, in a legible scale, depending on the size of the device; indication of the necessary clearance around the moving parts;

— detail drawings showing all the structural subassemblies which are not clearly discernible on the general drawings, as well as detail drawings of connections and individual items of a structural, mechanical or electrical nature, which can affect the safety of the amusement device and its operation, shall be drawn to a larger scale. Illustrations of the following items may be necessary for this purpose:

  — slewing gear, hoisting and swivelling mechanisms, including their support arrangements, drives and controls, lifting and swivelling ranges;

  — carriages, gondolas and similar, illustrated in all the required views and cross sections, with details of the overall dimensions, the internal dimensions of importance to the passengers (seats, side and back rests, leg and foot room), hand and foot holds and locking and securing devices;

  — motion gear with details of load, guide, and upstop wheels, bearings, axles, shafts and their attachment, freedom of movement in relation to the vehicle, steering and control, anti-rollback