ICS 97.200.40 SLOVENSKÁ TECHNICKÁ NORMA November 2019

STN	**Bezpečnosť kolotočov a zábavných zariadení Časť 1: Návrh a výroba**	**STN EN 13814-1** 55 1001

Safety of amusement rides and amusement devices - Part 1: Design and manufacture

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 10/19

Obsahuje: EN 13814-1:2019

Spolu s STN EN 13814-3 a STN EN 13814-2 od 01.06.2022 ruší
STN EN 13814 (55 1001) z októbra 2005

129418

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13814-1

May 2019

ICS 97.200.40 Supersedes EN 13814:2004

English Version

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

Sicherheit von Fahrgeschäften und Vergnügungseinrichtungen - Teil 1: Konstruktion, Bemessung und Herstellung

This European Standard was approved by CEN on 13 May 2018.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 13814-1:2019 E

Contents

Page

European foreword ... 6

Introduction ... 7

1 Scope ... 8

2 Normative references ... 8

3 Terms and definitions ... 11

4 Requirements for design analysis ... 16
4.1 Design documents ... 16
4.1.1 General ... 16
4.1.2 Design risk assessment ... 16
4.1.3 Description of design and operation ... 16
4.1.4 Design and manufacturing drawings ... 16
4.1.5 Principles of analysis ... 17
4.2 Selection of materials ... 18
4.2.1 General ... 18
4.2.2 Recommended steels ... 18
4.2.3 Aluminium alloy ... 19
4.2.4 Timber ... 19
4.2.5 Plastic composites ... 19
4.2.6 Concrete ... 19
4.2.7 Fasteners for structural components ... 19
4.2.8 Standards relating to ropes, chains, safety devices, connectors and adapters ... 19
4.3 Design loads ... 20
4.3.1 General ... 20
4.3.2 Permanent actions ... 21
4.3.3 Variable actions ... 21
4.3.4 Seismic forces ... 25
4.3.5 Applicable coefficients ... 26
4.3.6 Load combination ... 27
4.4 Structural analysis – Principles ... 28
4.4.1 General ... 28
4.4.2 Analysis principles for various types of rides ... 29
4.4.3 Other railways with track-bound vehicles ... 33
4.5 Verification of stability ... 34
4.5.1 Safety against overturning, sliding and lifting ... 34
4.6 Ground anchorage ... 36
4.6.1 General ... 36
4.6.2 Design load bearing capacity of weight anchors ... 37
4.6.3 Design load bearing capacity of rod anchors ... 37
4.6.4 Testing of anchors (Numbering) ... 39
4.6.5 Calculation of loads on anchors ... 39
4.6.6 Further requirements ... 40
4.6.7 Ground support for packing ... 41
4.7 Verification of strength ... 41
4.7.1 General ... 41
4.7.2 Predominantly static stress ... 42
4.7.3 Fluctuating stress ... 42
4.7.4 Bolts ... 45

4.7.5 Ropes, chains, safety devices, connectors and adapters 47
4.8 Structural design and construction 49
4.8.1 Arrangement, accessibility 49
4.8.2 Locking and safety devices for fasteners 49
4.8.3 Joints intended for regular dismantling 49
4.8.4 Designing of components subject to fluctuating loads 50
4.8.5 Supports 50
4.8.6 Central masts 50
4.8.7 Prevention of corrosion and rot 50
5 Requirements for design and manufacture of rides and structures 50
5.1 Risk reduction by prevailing design and safety measures 50
5.1.1 General 50
5.1.2 Risk assessment 51
5.1.3 Risk reduction for platforms, ramps, floors, stairs and walkways 52
5.1.4 Risk reduction by the use of barriers, fencing and guarding 56
5.1.5 Guarding of machinery parts 60
5.1.6 Risk reduction in the case of access and egress 60
5.1.7 Risk reduction for passengers units 62
5.1.8 Requirements by special provisions 74
5.2 Supplementary safety requirements for various types of amusement device 75
5.2.1 Amusement rides with vertical axis 75
5.2.2 Amusement rides with horizontal axis 77
5.2.3 Rail-guided channel or track-bound amusement devices 79
5.2.4 Dodgem cars/Bumper cars 81
5.2.5 Speedways/Go-karts 86
5.2.6 Mini-motorbikes for children 86
5.2.7 Boat rides 87
5.2.8 Flume rides 88
5.2.9 Helter skelters, slides, etc 89
5.2.10 Side shows, booths, win-a-prize and sales stands, mazes, halls of mirrors, fun houses, labyrinths, hammers, ring the bell and similar 90
5.2.11 Shooting stands and trailers, shooting devices 92
5.3 Mechanical systems 94
5.3.1 Hydraulic and pneumatic devices 94
5.3.2 Lifting and elevating units being integral part of a ride 96
5.4 Manufacture and supply 99
5.4.1 Manufacturer 99
5.4.2 Quality assurance — Quality plan 100
5.4.3 Manufacturing process 101
5.4.4 Safety precautions to be taken by the manufacturer 103
5.4.5 Electrical installations 103
5.5 Supply 103
5.5.1 Manuals 103
5.5.2 Special information 105
5.5.3 Drawings and diagrams 105
5.6 Design documentation 105
5.6.1 General 105
5.6.2 Description of installation and technical specification/information 106
5.7 Amusement Device Log 106
5.7.1 General 106
5.8 Official technical dossier 108
5.8.1 General 108

5.8.2 Content ... 108
5.8.3 Identification marking ... 109
Annex A (normative) Electrical equipment and control systems ... 110
A.1 Electrical equipment ... 110
A.1.1 General ... 110
A.1.2 Protection against electric shocks ... 110
A.1.3 Protection against lightning ... 111
A.1.4 Lighting ... 111
A.1.5 Generators ... 112
A.1.6 Heaters and light fittings ... 112
A.1.7 Communication system ... 112
A.2 Control Systems ... 112
A.2.1 General ... 112
A.2.2 Safety-related control functions ... 113
A.2.3 Safety-related parameters ... 114
A.2.4 Passenger restraints ... 115
A.2.5 Fall Prevention ... 116
A.2.6 Inhibiting of safety functions ... 117
A.2.7 Operating modes ... 118
A.2.8 Collision prevention safety function ... 120
Annex B (informative) Control systems - Best practices ... 122
B.1 Security ... 122
B.2 Example block zone logic ... 122
B.3 Requirements for the positioning of sensors and stopping devices ... 122
Annex C (informative) Guidance on design of passenger containment ... 124
Annex D (informative) Amusement Device Log for an amusement device ... 129
Annex E (informative) List of main hazards, hazardous situations and events for spectators and passengers during the operation and use of amusement rides ... 150
Annex F (informative) Guest behaviour ... 154
F.1 Scope ... 154
F.2 Terms and definitions ... 154
F.2.1 General ... 154
F.2.2 Boarding passengers ... 154
F.2.3 Riding passengers ... 154
F.2.4 Exiting passengers ... 154
F.2.5 Waiting passenger ... 154
F.2.6 Behaviour ... 154

F.2.7 Foreseeable behaviour ... 154
F.2.8 Parent or Supervision Companion ... 155
F.2.9 Child ... 155
F.2.10 Information to public ... 155
F.2.11 Parents or Supervision Companions accompanying children ... 155
F.3 Classification of age and basic capabilities ... 155
F.4 Human factors ... 157
F.5 General Strategy of Risk mitigation in Guest Behaviour ... 157
F.5.1 General ... 157
F.5.2 Adults ... 157
F.5.3 Refusal of access ... 158
F.5.4 Normal Behaviour ... 158
F.5.5 Unacceptable behaviour ... 158
Annex G (informative) Limited accessibility to amusement devices ... 159
Annex H (informative) Safety envelope for passengers ... 161
H.1 Design Criteria ... 161
H.2 Anthropometric Basis ... 161
H.3 Methods for Defining Safety Envelope Boundaries ... 161
H.3.1 Documentation ... 161
H.3.2 Prerequisites ... 162
H.3.3 Safety envelopes ... 162
H.3.4 Hazards and related safety envelope class ... 162
Annex I (informative) Acceleration effects on passengers ... 164
I.1 Medical tolerance – General ... 164
I.2 Rides ... 165
I.2.1 General ... 165
I.2.2 General Definitions and Limitations ... 165
I.2.3 Acceleration in X-Direction ... 165
I.2.4 Acceleration in Y-Direction ... 166
I.2.5 Acceleration in Z-direction (parallel to Spine) ... 167
I.2.6 Combinations ... 168
I.3 Reversals ... 169
I.3.1 Reversals in X and Y ... 169
I.3.2 Transitions in Z ... 170
I.4 Example obtaining admissible accelerations ... 172
Bibliography ... 174

European foreword

This document (EN 13814-1:2019) has been prepared by Technical Committee CEN/TC 152 "Fairground and amusement park machinery and structures - Safety", the secretariat of which is held by UNI.

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 November 2019, and conflicting national standards shall be withdrawn at the latest by May 2022.

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

This document, together with its second and third parts, supersedes EN 13814:2004.

EN 13814 consists of the following parts, under the general title *Safety of amusement rides and amusement devices:*

— *Part 1: Design and manufacture;*

— *Part 2: Operation, maintenance and use;*

— *Part 3: Requirements for inspection during design, manufacture, operation and use.*

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

Introduction

The object of this document is to define safety rules related to structures and machinery, which are either an integral part of, or constitute the amusement device itself. The safety rules are intended to safeguard persons against the risk of accidents caused by deficiencies in design, manufacture and operation of such structures and machinery.

Annex A (normative) provides guidance on electrical equipment and control systems

Annex B (informative) provides control systems – best practices

Annex C (informative) provides guidance of passenger containment

Annex D (informative) shows a typical layout of a device log for an amusement device

Annex E (informative) lists hazards pertaining to amusement rides

Annex F (informative) provides guidance on guest behaviour

Annex G (informative) provides guidance on the limited accessibility to amusement devices

Annex H (informative) provides guidance on the safety envelope for passengers

Annex I (informative) explains acceleration effects on passengers

1 Scope

This document specifies the minimum requirements necessary to ensure the safe design, calculation, manufacture, and installation of mobile, temporary or permanently installed machinery and structures which are intended for use by persons as a leisure activity, e.g. roundabouts, swings, boats, ferris wheels, roller coasters, chutes, booths, side shows, and structures for artistic aerial displays. The above items are hereafter called amusement devices, which 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. 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 (this list is not exhaustive) are not covered by this document.

For all the equipment not covered by the requirements of EN 13814-1, 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.

In terms of workers' health and safety, national regulations apply.

This document is applicable to manufacturing and major modification of amusement devices and rides for designs after the effective date of publication.

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.

EN 349, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

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

EN 1090-2:2018, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

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

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

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

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, *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 10204, *Metallic products - Types of inspection documents*

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

EN 13796-1, *Safety requirements for cableway installations designed to carry persons - Carriers - Part 1: Grips, carrier trucks, on-board brakes, cabins, chairs, carriages, maintenance carriers, tow-hangers*

EN 13814-2:2019, *Safety of amusement rides and amusement devices — Part 2: Operation, maintenance and use*

EN 13814-3:2019, *Safety of amusement rides and amusement devices — Part 3: Requirements for inspection during design, manufacture, operation and use*

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

EN 50172, *Emergency escape lighting systems*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2006)*

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

HD 60364-4-41, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock (IEC 60364-4-41)*

HD 60364-5-54, *Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors (IEC 60364-5-54)*

HD 60364-7-740, *Electrical installations 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 60364-7-740)*

EN 61558-1, *Safety of power transformers, power supplies, reactors and similar products - Part 1: General requirements and tests (IEC 61558-1)*

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

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

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

EN 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 898-1)*

EN ISO 3834-2, *Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements (ISO 3834-2)*

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

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

EN ISO 4014, *Hexagon head bolts - Product grades A and B (ISO 4014)*

EN ISO 4016, *Hexagon head bolts - Product grade C (ISO 4016)*

EN ISO 4017, *Fasteners - Hexagon head screws - Product grades A and B (ISO 4017)*

EN ISO 4018, *Hexagon head screws - Product grade C (ISO 4018)*

EN ISO 4032, *Hexagon regular nuts (style 1) - Product grades A and B (ISO 4032)*

EN ISO 4034, *Hexagon regular nuts (style 1) - Product grade C (ISO 4034)*

EN ISO 4413, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413)*

EN ISO 4414, *Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414)*

EN ISO 5817:2014, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2014)*

EN ISO 9606-1, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1)*

EN ISO 9606-2, *Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2)*

EN 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 9692-1)*

EN ISO 9692-2, *Welding and allied processes - Joint preparation - Part 2: Submerged arc welding of steels (ISO 9692-2)*

EN 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 9692-3)*

EN ISO 9712:2012, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012)*

EN ISO 10042:2018, *Welding - Arc-welded joints in aluminium and its alloys - Quality levels for imperfections (ISO 10042:2018)*

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

EN ISO 13849 (all parts), *Safety of machinery — Safety-related parts of control systems (ISO 13849)*

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

EN ISO 14119, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection (ISO 14119)*

EN ISO 14120, *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards (ISO 14120)*

EN ISO 14731, *Welding coordination - Tasks and responsibilities (ISO 14731)*

EN ISO 14732, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732)*

EN ISO 17635, *Non-destructive testing of welds - General rules for metallic materials (ISO 17635)*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14118, *Safety of machinery — Prevention of unexpected start-up*