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Cisterne za prevoz nevarnega blaga - Kovinske cisterne z gravitacijskim praznjenjem - Konstruiranje in izdelava (vključuje dopolnilo A1)

Tanks for the transport of dangerous goods - Metallic gravity-discharge tanks - Design and construction

Tanks für die Beförderung gefährlicher Güter - Metalltanks mit Entleerung durch Schwerkraft - Auslegung und Bau

Citernes pour le transport de matières dangereuses - Citernes métalliques à vidange par gravité - Conception et construction

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23.020.20	Posode in vsebniki, montirani na vozila	Vessels and containers mounted on vehicles

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Tanks for the transport of dangerous goods - Metallic gravity-discharge tanks - Design and construction

Citernes pour le transport de matières dangereuses - Citernes métalliques à vidange par gravité - Conception et construction

Tanks für die Beförderung gefährlicher Güter - Metalltanks mit Entleerung durch Schwerkraft - Auslegung und Bau

This European Standard was approved by CEN on 1 June 2020 and includes Amendment 1 approved by CEN on 28 April 2022.

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European foreword

This document (EN 13094:2020+A1:2022) has been prepared by Technical Committee CEN/TC 296 "Tanks for the transport of dangerous goods", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by November 2022, and conflicting national standards shall be withdrawn at the latest by November 2022.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 includes Amendment 1 approved by CEN on 28 April 2022.

This document supersedes ⟨A1⟩ EN 13094:2020 ⟨A1⟩.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟨A1⟩ ⟨A1⟩.

Compared with EN 13094:2015, the following are the principal changes that have been made:

a) changes to reflect the change in scope from low pressure to gravity-discharge applications;

b) updates to the normative references;

c) changes to the terms, definitions, symbols and abbreviations;

d) simplification of service equipment requirements by reference to regulatory requirements;

e) clarification of impact strength required at lower design temperatures;

f) new requirements on the cross-sectional shapes of shells for non-circular cross-sections, sumps and other external projections and cut-outs within the contour of a side or bottom of the shell;

g) clearer requirements on design verification;

h) expansion of provisions for the dynamic conditions used for tank design;

i) provisions for pressure conditions revised to reflect the change in scope;

j) clarification that maximum stress refers to maximum membrane stress;

k) expansion of requirements on shell thickness to clarify and include cut-outs;

l) addition of preferred location of tank top service equipment;

m) partial easing of restriction on longitudinal partitions;

n) additional requirements on pipes passing through the shell;

o) general revisions on the protection of service equipment mounted on the top of the tank;

p) new requirements for electrical bonding and earthing;

q) changes to the assessment criteria for welds not covered by either Annex D or EN 14025;

r) [A1] examination and testing of welds referred to EN 12972:2018;

NOTE 1 Acceptable equivalent requirements for the examination and testing of welds are given in subclause 7.4.4 of this document.

s) manufacturing tolerances referred to EN 12972:2018 [A1];

t) new requirements for minimum shell marking;

u) tank plate requirements addressed by reference to regulatory requirements;

v) clarification and revision of the application of the different methods of design verification in Annex A;

w) addition of finite element analysis as a method of measurement of specific resilience in Annex B;

x) changes to clarify the informative examples of welding details in Annex D; and

y) an addition to the bibliography.

This document has been submitted for reference in:

— the RID; and

— the technical annexes of the ADR.

NOTE 2 These regulations take precedence over any clause of this document. It is emphasized that RID/ADR are being revised regularly at intervals of two years which may lead to temporary non-compliances with the clauses of this document."

[A1] *deleted text* [A1]

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies requirements for the design and construction of metallic gravity-discharge tanks intended for the carriage of substances having a vapour pressure not exceeding 110 kPa (1,1 bar) (absolute pressure) at 50 °C.

NOTE 1 Gravity-discharge tanks have no maximum working pressure. However, during operation, pressure in the shell may occur, for example due to flow restrictions in vapour recovery systems or opening pressures of breather devices. It is important that these operating pressures do not exceed the test pressure of the tank or 0,5 bar, whichever is the highest.

This document specifies requirements for openings, closures, pipework, mountings for service equipment and structural equipment.

NOTE 2 This document does not specify requirements for items of service equipment other than pipes passing through the shell.

This document is applicable to aircraft refuelers that are used on public roads. It is also applicable to inter-modal tanks (e.g. tank containers and tank swap bodies) for the transport of dangerous goods by road and rail.

NOTE 3 This document is not applicable to fixed rail tank wagons.

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 10204, *Metallic products - Types of inspection documents*

EN 10028-2, *Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

⟨A1⟩ EN 12972:2018 ⟨A1⟩, *Tanks for transport of dangerous goods - Testing, inspection and marking of metallic tanks*

EN 13317, *Tanks for transport of dangerous goods - Service equipment for tanks - Manhole cover assembly*

EN 14025, *Tanks for the transport of dangerous goods - Metallic pressure tanks - Design and construction*

EN 13445-3:2014, *Unfired pressure vessels - Part 3: Design*

EN 14564, *Tanks for transport of dangerous goods - Terminology*

EN 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 3834-1)*

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

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

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

EN ISO 7500-1, *Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (ISO 7500-1)*

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

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 15607, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1)*

EN ISO 15609-2, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 2: Gas welding (ISO 15609-2)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613)*

EN ISO 15614 (all parts), *Specification and qualification of welding procedures for metallic materials - Welding procedure test (ISO 15614, all parts)*

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

EN ISO 17636-1, *Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film (ISO 17636-1)*

EN ISO 17637, *Non-destructive testing of welds - Visual testing of fusion-welded joints (ISO 17637)*

EN ISO 17640, *Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels, and assessment (ISO 17640)*

ISO 1496-3, *Series 1 freight containers - Specification and testing - Part 3: Tank containers for liquids, gases and pressurized dry bulk*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14564, EN 13445 and the following apply.

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

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

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

NOTE See also Figure A.1.

3.1.1
section modulus
second moment of area of a structure (and, where appropriate, its associated shell) about its neutral axis divided by the maximum distance from the neutral axis to the extreme fibre of the section used in the calculation

3.1.2
specific resilience
integral of the applied force and the measured deflection of a test piece up to the point at which the test bar punctures the test piece, as indicated by the point of maximum force

3.1.3
global resilience
ability of a shell with reinforcement(s) to withstand a sideways impact with a beam

3.1.4
mild steel
steel which has a minimum tensile strength between 360 N/mm² and 440 N/mm², and a steel referred to in EN material standards as “mild steel”, with a minimum tensile strength between 360 N/mm² and 490 N/mm² and a minimum elongation at fracture conforming to 5.2.2.3.1 calculated using the formula in 5.2.2.3.2

3.1.5
maximum design mass
sum of the unladen mass of the tank and the mass of the maximum permissible load for which the tank is designed

〚A1〛 3.1.6
reference steel
steel which has the properties defined in EN 14564 〈A1〉

3.2 Symbols

For the purposes of this document, the following symbols apply.

A	percentage (%) elongation after fracture
A_1	minimum percentage (%) elongation after fracture of the metal used (see 6.8.1)
B	pitch circle diameter or, if elliptical, average of major and minor diameters, in millimetres (mm)
c	distance from the start of a knuckle bend to the edge of a shell, in millimetres (mm) NOTE 1 This is used for the attachment of a dished end to a shell.
e	shell thickness, in millimetres (mm)
e_c	thickness of a flat closure, in millimetres (mm)
e_d	thickness of a domed closure, in millimetres (mm)
e_f	thickness of an end or partition, in millimetres (mm)
e_{rs}	thickness of a reinforcing section, in millimetres (mm)
e_r	thickness of an opening flange, in millimetres (mm)
e_{rd}	thickness of a domed closure flange, in millimetres (mm)
e_{vn}	adopted thickness(es) of a shell, in millimetres (mm)
$e_{v,\,min}$	minimum thickness of a shell according to 6.8.1, in millimetres (mm)
e_0	minimum thickness of shell in reference steel, in millimetres (mm)
e_1	thickness of the thickest part of a shell, in millimetres (mm)
e_2	thickness of the thinner part of the metal used, in millimetres (mm)
g	acceleration due to gravity, in metres per second squared (m/s^2) NOTE 2 The value of g is 9,81 m/s^2.
L	overlap of a lapped joint, in millimetres (mm)
L_c	length of reinforcing piece, in millimetres (mm)
L_r	length of reinforcing ring, in millimetres (mm)
L_0	initial gauge length of the test piece used in the tensile test, in millimetres (mm)
l	length of transition between plates of different thickness, in millimetres (mm)
l_1	length of overlap of swaged edge, in millimetres (mm)
l_2	length of weld at base of swaged joint, in millimetres (mm)
N	safety factor
P_{ta}	static pressure (gauge pressure), in MegaPascals (MPa)
P_e	tank test pressure, in MegaPascals (MPa)
P_{ec}	compartment test pressure, in MegaPascals (MPa)
P_c	calculation pressure of the tank, in MegaPascals (MPa)
P_{dyn}	dynamic pressure, in MegaPascals (MPa)
P_{ts}	opening pressure of the breather device, in MegaPascals (MPa)

R internal radius of a domed closure, in millimetres (mm)

R_d determined tensile strength, in Newtons per square millimetre (N/mm²)

R_e apparent yield strength for steels having a clearly defined yield point or guaranteed 0,2 % proof strength for steels with no clearly defined yield point (1 % proof strength for austenitic steels) Newtons per square millimetre (N/mm²)

R_{et} apparent yield strength for steels having a clearly defined yield point or guaranteed 0,2 % proof strength for steels with no clearly defined yield point (1 % proof strength for austenitic steels) at minimum design temperature Newtons per square millimetre (N/mm²)

R_m tensile strength, in Newtons per square millimetre (N/mm²)

R_{mt} tensile strength at minimum design temperature, in Newtons per square millimetre (N/mm²)

R_{m1} minimum tensile strength of the metal used, in Newtons per square millimetre (N/mm²)

S_B total tensile area, in square millimetres (mm²)

S_0 initial cross-sectional area of a test piece used in the tensile test, in square millimetres (mm²)

w effective depth of fillet weld (i.e. distance from the surface of the weld to the minimum penetration point of the molten metal into the base material)

Z_0 minimum section modulus in reference steel, in cubic centimetres (cm³)

Z_1 minimum section modulus in the metal used, in cubic centimetres (cm³)

σ_c design stress for cover material, according to 6.8, in newtons per square millimetre (N/mm²)

σ_r design stress for flange material, according to 6.8, in newtons per square millimetre (N/mm²)

3.3 Abbreviations

FEM Finite element method

4 Service equipment

As a minimum, the service equipment shall be in conformance with the relevant regulations.

〚A1〛 Tanks shall be equipped with a breather device and a safety device to prevent the contents from spilling out if the tank overturns. For compartmented tanks, each compartment shall be so equipped.

NOTE 1 Referenced standards for service equipment are listed in ADR 6.8.2.6. 〚A1〛

NOTE 2 For pipework passing through the shell, see 6.13.

5 Materials

5.1 General

5.1.1 The designer shall select the materials to be used in the construction of the shell using ferritic steel, austenitic steel, austenitic-ferritic stainless steel or aluminium alloy material standards published by a national or international standards body or otherwise approved by the competent authority. The material shall in any case meet the requirements specified in 5.2.

5.1.2 Materials used in the construction of shells shall be suitable for shaping. Materials shall be deemed unsuitable if, even though they meet the material requirements of this document, the degree of shaping required by a particular shell design generates cracking or other signs of distress in the shell material.

5.1.3 Materials shall be used that are known to be resistant to brittle fracture and to stress corrosion cracking.

5.1.4 When tested in accordance with the appropriate clauses of EN ISO 15614-1, the properties of materials used in the fabrication of welded shells shall not be less than the minimum values specified for the material selected in accordance with 5.1.1 throughout the welded area after welding without post-weld heat treatment.

5.2 Material properties

5.2.1 Impact strength

Ferritic steel materials shall only be used when the material standard (e.g. EN 10028-2) guarantees an impact strength of at least 34 J/cm² at −20 °C. If a lower design temperature is prescribed, this strength shall be achieved at the lower temperature.

5.2.2 Yield strength, tensile strength and elongation after fracture

5.2.2.1 General

5.2.2.1.1 The values of A, R_e and R_m to be used shall be the minimum values specified for the material selected in accordance with the relevant standard for the material with the exception of 5.2.2.1.2 and 5.2.2.1.3.

5.2.2.1.2 When austenitic steels are used, the value of R_e and R_m used in the calculation may exceed the minimum value in accordance with the relevant standard for the material specified for the material selected provided that:

— the higher values are attested in a certificate 3.1 or 3.2 issued in accordance with EN 10204; and

— the value of R_e and R_m used in the calculation does not exceed 1,15 multiplied by the value of R_e A1 and R_m A1 as specified for the material selected in accordance with the relevant standard for the material.

5.2.2.1.3 When fine-grained steels are used, the value of R_e shall not exceed 460 N/mm² and the value of R_m shall not exceed 725 N/mm² in accordance with the specifications of the relevant standard for the material.

5.2.2.2 Yield strength and tensile strength

Steels with a ratio of R_e/R_m exceeding 0,85 shall not be used in the construction of welded shells. The values specified in certificate 3.1 or 3.2 issued in accordance with EN 10204 shall be used to determine the R_e/R_m ratio.

5.2.2.3 Elongation after fracture

5.2.2.3.1 The material shall be tested in accordance with EN ISO 6892-1. The percentage elongation after fracture, A, shall be not less than:

— 16 % for fine grained steels;

— 20 % for other steels; and

— 12 % for aluminium alloys.

5.2.2.3.2 Additionally, for steel, the percentage elongation after fracture, A, shall not be less than the value calculated using Formula (1):

$$A = \frac{10\ 000\,\mathrm{N/mm^2}}{R_\mathrm{d}} \tag{1}$$

NOTE For A and R_d only the numerical value with the unit according to 3.2 is given.

5.2.2.3.3 For sheet metal, when measuring the percentage elongation after fracture in accordance with EN ISO 6892-1, the axis of the tensile test piece shall be at right angles to the direction of rolling; where the material standard gives lower values in the direction of rolling, these values shall be used in the calculation.

5.2.2.3.4 When measuring the percentage elongation after fracture, a test piece of circular cross-section shall be used in which the initial gauge length is equal to five times the diameter. If test pieces of rectangular section are used, the gauge length shall be calculated using Formula (2):

$$L_0 = 5{,}65\sqrt{s_0} \tag{2}$$

NOTE Elongations based on fixed lengths can be converted to proportional elongations using EN ISO 2566-1 or EN ISO 2566-2 as applicable.

5.3 Compatibility of tank materials with substances carried

5.3.1 The manufacturer shall make available a list of the dangerous goods that may be carried without damage to the tank, or as applicable, its lining. The substances or group of substances approved in the certificate shall be compatible with the characteristics of the tank.

NOTE RID/ADR (4.3.4.1.2) states that the listing of approved substances may be replaced by groups of substances according to the tank code taking into account any relevant special provision.

5.3.2 If contact between the substance carried and the material used for the construction of the shell is deemed likely to entail a progressive decrease in the thickness of the shell, this thickness shall be increased at manufacture by an appropriate amount.

NOTE This additional thickness, to allow for corrosion, is not taken into consideration in determining the minimum shell thickness (see 6.8.1).

5.3.3 If the shell is fitted with a non-metallic protective lining, only materials and their means of bonding to the shell that are known to remain leakproof, whatever the deformation liable to occur in normal conditions of carriage, shall be used.

5.3.4 If shells intended for the carriage of liquids having a flash-point of not more than 60 °C are fitted with non-conductive protective linings, precautions shall be taken to prevent the accumulation of electrostatic charges that could present a danger of ignition.

NOTE 〖A1〉 In RID/ADR (7.5.10), this requirement is also applicable to UN No. 1361 carbon and UN No. 1361 carbon black, packing group II. 〈A1〗