SLOVENSKI STANDARD
oSIST prEN 14359:2026

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Hidropnevmatski akumulatorji za hidravlične sisteme

Gas-loaded accumulators for fluid power applications

Hydrospeicher für Hydraulikanwendungen

Accumulateurs hydropneumatiques pour transmissions hydrauliques

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ICS:

23.100.99	Drugi sestavni deli hidravličnih sistemov	Other fluid power system components

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EUROPEAN STANDARD

NORME EUROPÉENNE

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English Version

Gas-loaded accumulators for fluid power applications

Accumulateurs hydropneumatiques pour transmissions hydrauliques

Hydrospeicher für Hydraulikanwendungen

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European foreword

This document (prEN 14359:2026) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14359:2017.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

In comparison with EN 14359:2017, the following modifications have been made:

— in general, references have been aligned to the new Pressure Equipment Directive 2014/68/EU;

— the Scope has been broadened so as not to specifically exclude accumulators containing Group 1 liquids or gases;

— in Table 2, allowable design stress values for ‘fine grained and heat-treated steels' have been added;

— in 5.9 ‘Fatigue performance evaluation’, the normative text has been refined and the clause has been relocated to within Clause 5;

— more information is provided in the informative Annexes C to F;

— in the Annexes: Conformity assessment modules and activities have been removed from this edition;

— informative Annexes B and ZA have been updated to take into account the European Legislation on Pressure Equipment.

Where appropriate, formulae and techniques are consistent with the requirements of EN 13445-3:2026.

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1 Scope

1.1 This document specifies the requirements for materials, design, manufacture, testing inspection, safety equipment configuration and documentation (including instructions for first operation), for commonly-used types of gas-loaded accumulators and pressure vessels used to provide additional gas capacity for fluid power applications (see 1.2).

1.2 This document applies to the following types of components, defined as the pressure-containing envelope of gas-loaded accumulators:

— bladder type;

— diaphragm type;

— piston type;

— transfer type;

— pressure vessels used to provide additional gas capacity.

They consist of one or several parts joined together by a variety of mechanical means and by welding.

1.3 This document applies to gas-loaded accumulators which operate with the following conditions:

— subject to an internal gauge pressure greater than 0,5 bar;

— working temperature not lower than –50 °C and not higher than +200 °C;

— containing all liquids and gases as defined in the European Legislation on Pressure Equipment, see Note.

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NOTE When the accumulator contains Group 1 liquids or gases, consideration relating to risks other than those required by the European Legislation on Pressure Equipment are not covered by this document and will be assessed separately.

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 10204:2004, *Metallic products - Types of inspection documents*

EN 10228-3:2016, *Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings*

EN 13018:2016, *Non-destructive testing - Visual testing - General principles*

EN 13445-2:2026, *Unfired pressure vessels - Part 2: Materials*

EN 13445-3:2026, *Unfired pressure vessels - Part 3: Design*

EN 13445-4:2026, *Unfired pressure vessels - Part 4: Fabrication*

EN ISO 148-1:2016, *Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2016)*

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EN ISO 898-1:2013, *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 898-1:2013)*

EN ISO 9015-1:2011, *Destructive tests on welds in metallic materials - Hardness testing – Part 1: Hardness test on arc welded joints (ISO 9015-1:2001)*

EN ISO 6506-1:2014, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:2014)*

EN ISO 6892-1:2019, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)*

EN ISO 10893-10:2011,[1] *Non-destructive testing of steel tubes – Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-10:2011)*

EN ISO 15614-1:2017,[2] *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 15614-1:2017, Corrected version 2017-10-01)*

ISO 262:2023, *ISO general purpose metric screw threads - Selected sizes for bolts, screws, studs and nuts*

ISO 9110-1:2020, *Hydraulic fluid power - Measurement techniques - Part 1: General measurement principles*

ISO 9110-2:2020, *Hydraulic fluid power - Measurement techniques - Part 2: Measurement of average steady-state pressure in a closed conduit*

ISO 10771-1:2015, *Hydraulic fluid power - Fatigue pressure testing of metal pressure-containing envelopes - Part 1: Test method*

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3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
gas-loaded accumulator
hydraulic accumulator with separator between liquid and gas where the liquid is pressurized using the compressibility of an inert gas (e.g. nitrogen)

Note 1 to entry: The separator can be a bladder, a diaphragm or a piston.

Note 2 to entry: Gas-loaded accumulators have shells, which can consist of cylinders, dished ends and flat plates. Openings are always isolated, located on the axis centre line and positioned at both ends of the accumulator. It is assumed that such vessels are axis-symmetrical.

[1] As impacted by EN ISO 10893-10:2011/A1:2020.
[2] As impacted by EN ISO 15614-1:2017/A1:2019.

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3.1.2
bladder accumulator
gas-loaded accumulator consisting of pressure-retaining shell, either spun-forged from seamless tube, hammer-forged from hollow bar or of welded construction, in which the liquid and gas are separated by a flexible bag or bladder normally retained at one end of the shell

3.1.3
diaphragm accumulator
gas-loaded accumulator consisting of pressure-retaining shell assembly, in which the construction can either be screwed or welded, with integral ports in which the liquid and gas are separated by a flexible membrane normally retained at its largest diameter to the shell

3.1.4
piston accumulator
gas-loaded accumulator consisting of cylinder body and end cap assemblies in which the liquid and gas are separated by a rigid sliding piston

3.1.5
transfer type accumulator
gas-loaded accumulator with a port for connecting additional gas capacity from one or more pressure vessels (e.g. gas bottle)

3.1.6
pressure vessels – providing additional gas capacity
inter-connected pressure vessels consisting of body and, depending upon construction, port assemblies used to provide additional gas capacity and communicating with the gas chamber of the accumulator by means of a pipe connection

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3.1.7
cylinder
right circular cylinder

Note 1 to entry: See Figure 3.

3.1.8
torispherical end
dished end, made up of a spherical cap, a toroidal knuckle and a cylindrical shell, the three components having common tangents where they meet

Note 1 to entry: See Figures 4 and 5.

3.1.9
Klöpper-type
torispherical end for which $R/D_e = 1{,}0$ and $r/D_e = 0{,}1$

Note 1 to entry: See Figure 5.

3.1.10
Korbbogen-type
torispherical end for which $R/D_e = 0{,}8$ and $r/D_e = 0{,}154$

Note 1 to entry: See Figure 5.

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3.1.11
weld procedure specification
document that outlines the specific parameters and variables required to produce a weld that meets defined standards and requirements

3.2 Symbols and units

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

Table 1 — Symbols, characteristics and units

Symbol	Characteristics	Unit
c	Corrosion allowance	mm [a]
D_e	Outside diameter of the shell	Mm
D_i	Inside diameter of the shell	Mm
D_m	Mean diameter of shell	Mm
e	Required thickness of the component	mm [a]
e_a	Analysis thickness of the component	mm [a]
e_{min}	Minimum possible fabrication thickness	mm [a]
e_n	Nominal thickness of the component, as specified on the manufacturing detail drawings	mm [a]
e_s	Required thickness of end to limit membrane stress in central part of shell	Mm
e_y	Required thickness of knuckle to avoid axis-symmetric yielding	Mm
f	Nominal design stress at design temperature	MPa [b]
f_a	Nominal design stress at test temperature	MPa [b]
f_{shear}	Nominal design shear stress at design temperature	MPa [b]
f_{test}	Nominal design stress for testing conditions	MPa [b]
δ_e	Absolute value of the negative tolerance on the nominal thickness taken from the material standard of the component	mm [a]
δ_m	Possible thinning during manufacturing process of the component	mm [a]
h	Internal height of dished end measured from cylindrical part	Mm
N	Number of pressure cycles	
P_0	Pre-charging pressure; the gas pressure in the accumulator when the hydraulic circuit is not under pressure (initial state) at a temperature of (20 ± 5) °C	MPa [b]
P_1	Minimum working pressure of the hydraulic circuit	MPa [b]
P_2	Maximum working pressure of the hydraulic circuit	MPa [b]

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Symbol	Characteristics	Unit
P_2/P_0	Allowable pressure ratio below which the accumulator type can be used	
P_3	Set pressure of the safety accessory for the accumulator, if one is fitted	MPa [b]
PS	Maximum allowable pressure	MPa [b]
P_{test}	Test pressure	MPa [b]
r	Inside radius of curvature of a knuckle	mm
R	Inside spherical radius of central part of torispherical end	mm
R_{eH}	Minimum upper yield strength	MPa [b]
R_m	Minimum tensile strength	MPa [b]
$R_{m/t}$	Minimum tensile strength at design temperature t °C	MPa [b]
$R_{p0,2}$	Minimum 0,2 % - proof strength	MPa [b]
$R_{p0,2/t}$	Minimum 0,2 % - proof strength at design temperature t °C	MPa [b]
$R_{p1,0}$	Minimum 1,0 % - proof strength	MPa [b]
$R_{p1,0/t}$	Minimum 1,0 % - proof strength at design temperature t °C	MPa [b]
TS_{max}	Maximum operating temperature of the hydraulic fluid or of the environment, whichever is higher or equal	°C
TS_{min}	Minimum operating temperature of the hydraulic fluid or of the environment, whichever is lower or equal	°C
V	Internal volume of the gas chamber	litre
V_0	Gas volume at pressure P_0	litre
V_1, V_2	Volumes occupied by the gas contained in the accumulator and the additional chambers, if any, at pressures P_1 and P_2 at their respective temperatures	litre
z	Weld joint coefficient	— [c]

[a] The relationships between the defined thicknesses are shown in Figure 1.

[b] MPa for calculation purposes only, otherwise the unit should be bar (1 MPa = 10 bar).

[c] See EN 13445-3:2026.

The inter-relation of the various definitions of thickness is shown in Figure 1.

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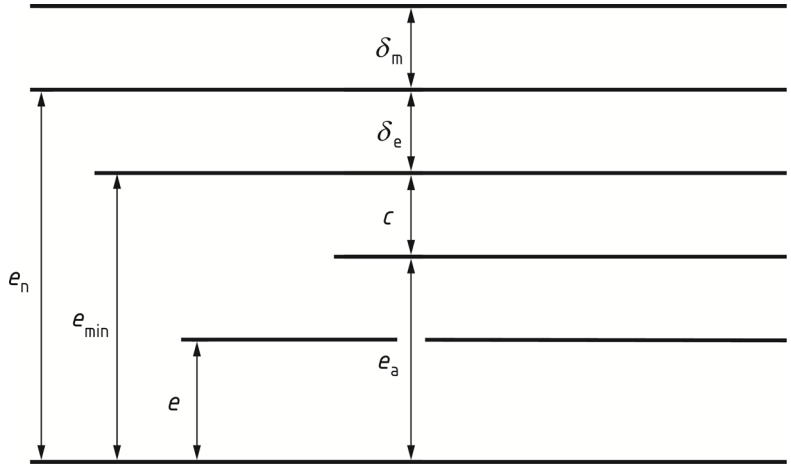

Key

c	corrosion allowance
e	required thickness
e_a	analysis thickness ($e_a = e_{min}$-c)
e_{min}	minimum possible fabrication thickness
e_n	nominal thickness
δ_e	absolute value of the negative tolerance taken from the material standard of the component
δ_m	possible thinning during manufacturing process of the component

Figure 1 — Relationship of thickness definitions

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4 Materials

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4.1 Requirements for metallic materials

The pressure containing envelope of gas-loaded accumulators shall be constructed of either:

— harmonized materials used for the manufacture of unfired pressure vessels and meeting the requirements of EN 13445-2:2026;

— materials other than those specified in EN 13445-2:2026 provided that they have been accepted by a particular material appraisal;

— materials whose references have been published in the Official Journal of the European Union.

4.2 Material certificates for components of the pressure containing envelope

Components used in the manufacture of the pressure containing envelope of gas-loaded accumulators to category II, III and IV according to Annex II of the European Legislation on Pressure Equipment shall be accompanied by an inspection document in accordance with EN 10204:2004, type 3.1. Such components shall include, but not be limited to, those determined by the application of the calculation formulae within this document.

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5 Basic design and calculation criteria

5.1 General

The requirements of Clause 5 shall apply when the materials and welds are not subject to localized corrosion in the presence of either products which the gas-loaded accumulator is to contain, or the environment in which it is located.

5.2 Protection against corrosion and erosion

Protection against corrosion and erosion shall be in accordance with EN 13445-3:2026, 5.2.

5.3 Qualification by similarity

Accumulators are often serially produced and it is possible to qualify a range of accumulators based upon the design, calculation and testing of one model within the range provided that other accumulators are similar. Two accumulators are similar provided that:

— they are made of the same material of the same form and origin;

— they are identical with the exception of length;

— the internal length of the cylindrical portion is not less than three times its external diameter.

If the length of the cylindrical portion is less than three times its external diameter, then a detailed stress analysis in accordance with EN 13445-3:2026, Clause 18 shall be undertaken.

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5.4 Design methods

5.4.1 General

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This document specifies requirements for designing accumulators or their components using formulae. Conformance is achieved when these requirements are met, and the accumulator undergoes fewer than 500 pressure cycles between P_2 and P_1 during its lifetime.

Where the accumulator will be subjected to more than 500 pressure cycles between P_2 and P_1, an assessment for the effects of fatigue, either by analysis or test is required. This assessment shall form part of the Technical File.

Clauses 17 and 18 of EN 13445-3:2026 shall be used as the basis for a fatigue analysis and 5.9 of this document shall be used as the method for conducting a fatigue cycling test.

The design process in Figure 2 shall be adopted.

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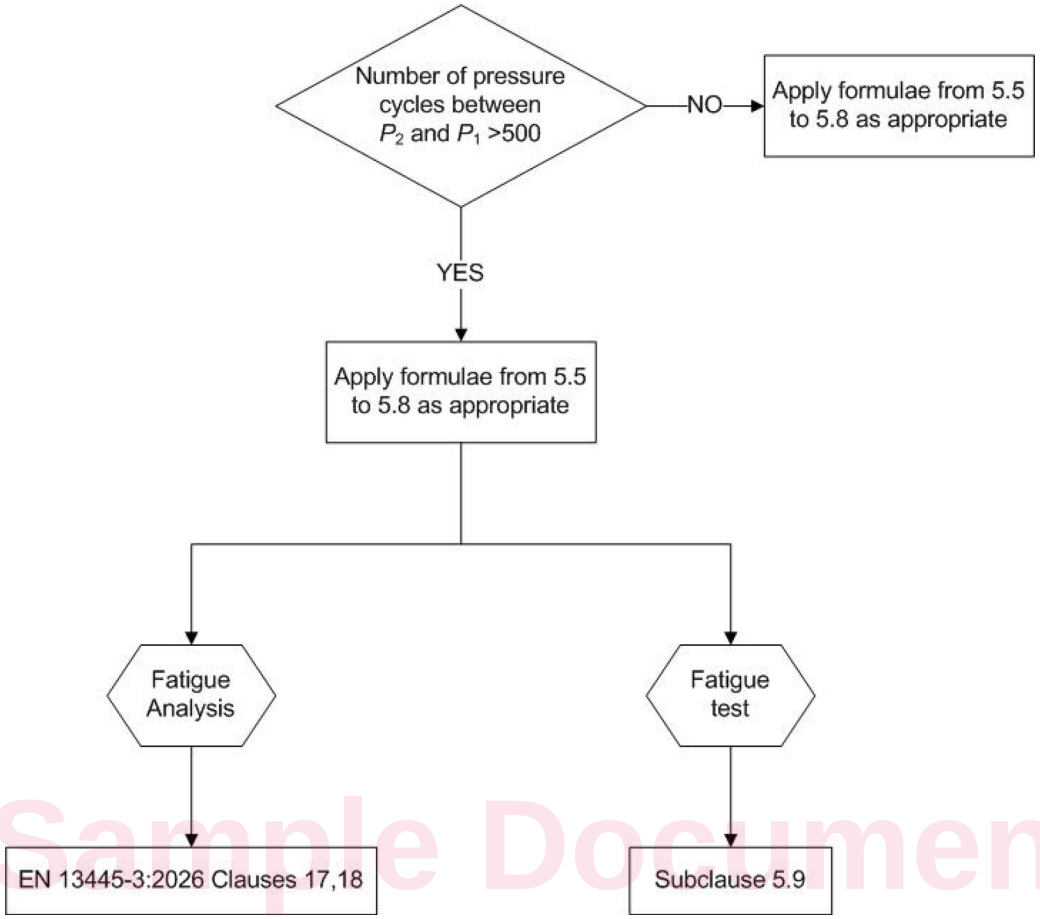

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Figure 2 — Design process

5.4.2 Maximum allowable values for the nominal design stress for pressure bearing parts

This subclause specifies maximum allowable values for the nominal design stress for pressure parts other than bolts and physical properties of steels.

Maximum values for the nominal design stress at operating temperatures shall be calculated in accordance with Table 2.

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Table 2 — Maximum allowable values of the nominal design stress for pressure parts other than bolts

	Normal	Under test conditions
Austenitic steels with 30 % < A ≤ 35 %	$f = \frac{R_{p1,0/t}}{1,5}$	$f_{test} = \frac{R_{p1,0/t_{test}}}{1,05}$
Austenitic steels with A > 35 %	$f = \text{MAX}\left[\left(\frac{R_{p1,0/t}}{1,5}\right); \text{MIN}\left(\frac{R_{p1,0/t}}{1,2}; \frac{R_{m/t}}{3}\right)\right]$	$f_{test} = \text{MAX}\left(\frac{R_{p1,0/t_{test}}}{1,05}; \frac{R_{m/t_{test}}}{2}\right)$
Cast steels	$f = \text{MIN}\left(\frac{R_{p0,2/t}}{1,9}; \frac{R_{m/20}}{3}\right)$	$f_{test} = \frac{R_{p0,2/t_{test}}}{1,33}$
Steels other than austenitic with A < 30 %	$f = \text{MIN}\left(\frac{R_{p0,2/t}}{1,5}; \frac{R_{m/20}}{2,4}\right)$	$f_{test} = \frac{R_{p0,2/t_{test}}}{1,05}$
Fine grained and heat treated steels	$f = \frac{R_{p0,2/t}}{1,5}$	$f_{test} = \frac{R_{p0,2/t_{test}}}{1,05}$

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5.5 Design and calculation methods common to all accumulator types

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5.5.1 General

All applicable formulae shall be used in order to demonstrate conformity with this document. If the formulae are not applicable due to the specific geometry of the design, then a fatigue assessment/evaluation is necessary, according to either Clauses 17 and 18 of EN 13445-3:2026 or subclause 5.9, in order to determine P_2/P_0 and PS.

NOTE The maximum allowable pressure PS can be replaced by the test pressure PT when calculating for test conditions.

5.5.2 Specific calculations

5.5.2.1 Cylindrical shells

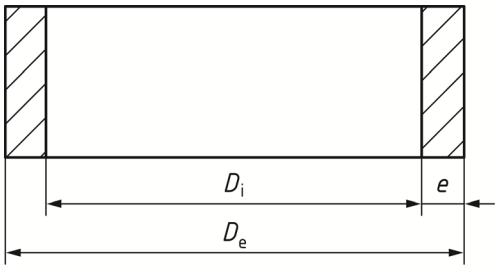

Figure 3 — Geometry for cylindrical shells

The required wall thickness e shall be calculated by:

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