SLOVENSKI STANDARD
SIST EN 18191:2026

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Industrijski ventili - Dodatne zahteve za kovinske ventile za vodik

Industrial valves - Additional requirements for metallic valves for hydrogen application

Industriearmaturen - Zusätzliche Anforderungen an metallische Armaturen für Wasserstoffanwendungen

Robinetterie industrielle - Exigences supplémentaires pour les appareils de robinetterie métalliques pour application hydrogène

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Industrial valves - Additional requirements for metallic valves for hydrogen application

Robinetterie industrielle - Exigences supplémentaires pour les appareils de robinetterie métalliques pour application hydrogène

Industriearmaturen - Zusätzliche Anforderungen an metallische Armaturen für Wasserstoffanwendungen

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European foreword

This document (EN 18191:2026) has been prepared by Technical Committee CEN/TC 69 "Industrial valves", 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of an identical text or by endorsement, at the latest by February 2027, and conflicting national standards shall be withdrawn at the latest by February 2027.

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.

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Introduction

Metallic industrial valves are considered as essential pressure accessories in hydrogen applications. They are used in various hydrogen technologies and applications, for example production, processing, storage, transportation, distribution, and usage.

Metallic industrial valves are integral pressure accessories of industrial piping, gas transportation and distribution systems.

CEN/TC 69 worked in cooperation with the following other technical committees: CEN/TC 267, CEN/TC 54, CEN/TC 234 and CEN/TC 235.

This document defines additional requirements for metallic industrial valves for hydrogen application from those in published European standards.

The document is an application standard to provide consolidation of requirements on known and proven solutions for hydrogen applications. Furthermore, it is intended to describe or exclude specific specifications for hydrogen service.

For this purpose, this document addresses damage mechanisms of hydrogen services, which might exist in combinations.

1 Scope

This document applies to industrial metallic valves for hydrogen use. It contains recommendations and additional requirements applicable to material selection, design, manufacture, and final assessment.

This document addresses the following four services/damage mechanisms, which might exist in combinations:

— low temperature applications;

— hydrogen environmental embrittlement (HEE) or hydrogen-induced cracking (HIC);

— high temperature hydrogen attack (HTHA);

— hydrogen service with cyclic loads (fatigue).

This document considers the difference between gaseous hydrogen (GH2) and liquid hydrogen (LH2), where necessary.

The additional provisions set out in this document do not cover corrosion such as electro-chemical corrosion of metals under participation of hydrogen (e.g. sour gas).

This document is based on the requirements contained in the standards specified below:

— applications with a maximum allowable pressure PS greater than 0,5 bar in accordance with the European legislation for pressure equipment, the applicable provisions of EN 16668 apply;

— additional requirements for valves in chemical and petrochemical applications are specified in EN 12569;

— additional requirements for valves in gas distribution systems are specified in EN 13774;

— additional requirements for valves in gas transportation systems are specified in EN 14141.

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 19, *Industrial valves - Marking of metallic valves*

EN 736-1, *Valves - Terminology - Part 1: Definition of types of valves*

EN 736-2, *Valves - Terminology - Part 2: Definition of components of valves*

EN 736-3, *Valves - Terminology - Part 3: Definition of terms*

EN 1011 (all parts), *Welding - Recommendations for welding of metallic materials*

EN 1708-1, *Welding - Basic welded joint details in steel - Part 1: Pressurized components*

EN 1708-2, *Welding - Basic weld joint details in steel - Part 2: Non internal pressurized components*

EN 1976, *Copper and copper alloys - Cast unwrought copper products*

EN 12074, *Welding consumables - Quality requirements for manufacture, supply and distribution of consumables for welding and allied processes*

EN 12266-1, *Industrial valves - Testing of metallic valves - Part 1: Pressure tests, test procedures and acceptance criteria - Mandatory requirements*

EN 12266-2, *Industrial valves - Testing of metallic valves - Part 2: Tests, test procedures and acceptance criteria - Supplementary requirements*

EN 13479, *Welding consumables - General product standard for filler metals and fluxes for fusion welding of metallic materials*

EN 16668:2025, *Industrial valves - Requirements and testing for metallic valves as pressure accessories*

EN ISO 3651-2:1998, *Determination of resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)*

EN ISO 15792-1, *Welding consumables - Test methods - Part 1: Preparation of all-weld metal test pieces and specimens in steel, nickel and nickel alloys (ISO 15792-1)*

EN ISO 15848-1:2015, *Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves (ISO 15848-1:2015)*

EN ISO 15848-2, *Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 2: Production acceptance test of valves (ISO 15848-2)*

EN ISO 28921-1, *Industrial valves - Isolating valves for low-temperature applications - Part 1: Design, manufacturing and production testing (ISO 28921-1)*

EN ISO 28921-2, *Industrial valves - Isolating valves for low-temperature applications - Part 2: Type testing (ISO 28921-2)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 736-1, EN 736-2, EN 736-3 and the following 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
diffusion
flux of a fluid through another fluid or material due to concentration gradient

EXAMPLE The motion of hydrogen gas through air, or the movement of hydrogen gas through the wall of a rubber hose.

Note 1 to entry: The diffusion coefficient is the mass of material diffusing across a unit of area in a unit of time at a unit concentration gradient.

[SOURCE: ISO/TR 15916:2015, 3.29]

3.2
fugitive emission
chemical or mixture of chemicals, in any physical form, which represents an unanticipated or spurious leak from equipment on an industrial site

[SOURCE: EN ISO 15848-1:2015, 3.5]

3.3
gaseous hydrogen
hydrogen under gaseous form

[SOURCE: ISO 14687:2019, 3.10]

3.4
glass transition
reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one

[SOURCE: EN ISO 472:2013, 2.440]

3.5
glass transition temperature
Tg
approximate midpoint of the temperature range over which the glass transition takes place

Note 1 to entry: The glass transition temperature varies significantly, depending upon the specific property and the test method and conditions selected to measure it.

Note 2 to entry: The glass transition temperatures of polymers and elastomers describe the temperature ranges at which polymers and elastomers turn from a hard, brittle material (below *Tg*) to a ductile or elastic material (above or equal *Tg*).

[SOURCE: EN ISO 472:2013, 2.441, modified— Symbol “*Tg*” added, Note 2 to entry added]

3.6
hardness
property of a material involving resistance to indentation, deformation, and/or abrasion

Note 1 to entry: It is measured as yield strength, work hardening, true tensile strength, modulus of elasticity, and other material characteristics.

3.7
high-temperature hydrogen attack
HTHA
damage mechanism which results from exposure of steels to hydrogen gas at elevated temperatures and pressures; dissociated hydrogen atoms react with carbon and carbides in the steel to form CH4

3.8
hydrogen
colourless, odourless, tasteless and flammable substance that is the simplest chemical element in the periodic table.

3.9
hydrogen applications
wide range of industrial processes handling hydrogen in the physical state gaseous or liquified and gas mixtures with H_2 in various concentrations

3.10
hydrogen compatibility
ability of a material to exhibit and maintain reliable mechanical integrity and low probability of failure, or leakage, in hydrogen applications within accepted risk parameters

Note 1 to entry: Hydrogen compatibility is a function of material susceptibility, application, applied stress and environment.

3.11
hydrogen environmental embrittlement
HEE
loss in strength, ductility, and/or fracture toughness of susceptible materials due to the penetration and diffusion of atomic hydrogen resulting from gaseous environment that can lead to brittle cracking

Note 1 to entry: The term HEE is more appropriate to describe these phenomena, but in some parts of the industries it might be referred to as hydrogen induced cracking (HIC).

3.12
hydrogen partial pressure
HPP
total operating pressure multiplied by mole fraction or percentage volume of hydrogen

Note 1 to entry: HPP is calculated as the mole fraction of hydrogen multiplied by the total pressure of the mixture.

3.13
liquid hydrogen
hydrogen that has been liquefied, i.e. brought to a liquid state

[SOURCE: ISO 14687:2019, 3.1.15]

3.14
permeability
rate of transmission of a pressurized gas through a material

[SOURCE: ISO/TR 15916:2015, 3.78]

3.15
permeation
flow of a media through another (usually solid) material by diffusion without a defect or opening of the latter

Note 1 to entry: To be distinguished from leak flow which is not based on diffusion.

[SOURCE: ISO/TR 15916:2015, 3.79]

3.16
rapid gas decompression
RGD
depressurization
explosive decompression
rapid pressure-drop in a high pressure gas-containing system which disrupts the equilibrium between external gas pressure and the concentration of gas dissolved inside any polymer, with the result that excess gas tries to escape from the solution at points throughout the material, causing expansion

Note 1 to entry: If large enough, and if the pressure drop rate is faster than the natural gas diffusion rate, blistering or rupturing can occur.

[SOURCE: ISO 23936-2:2011, 3.1.10]

3.17
shell
pressure containing envelope of the valve

Note 1 to entry: It normally comprises the body and when included in the design a bonnet or cover and the body.

[SOURCE: EN 736-2:2016, 3.1]

3.18
sour gas
gas containing significant amount of acid gases such as carbon dioxide and sulphur compounds

Note 1 to entry: Sour gas is failing the qualification as pipeline quality natural gas due to the inclusion of undesirable components such as hydrogen sulfide (H_2S) or carbon dioxide in significantly greater amounts than those quoted for pipeline quality natural gas.

[SOURCE: EN ISO 14532:2017, 2.1.1.8, modified — Notes to entry removed and new Note 1 to entry added

3.19
trim
functional components of a valve excluding the shell components which are in contact with the fluid inside the valve

Note 1 to entry: The components are specified in the relevant product standards. Table B.1 provides an overview.

Note 2 to entry: Metallic trim components are categorized into two subgroups, based on the requirement that the component is under an applied stress for the effect of hydrogen degradation of metallic materials to occur:

— loaded: trim components that are under tension or torsion, that is either constant or cyclic;

— other: all other trim components, either with no applied load or in compression.

[SOURCE: EN 736-2:2016, 3.2, modified — Note 1 and Note 2 to entry added]

3.20
wetted sub-components
components fitted inside a valve exposed to or in direct contact with the medium, that do not fall under the definition of trim nor shell

4 General

This document does not claim to define or restrict hydrogen applications as intended use in detail. It considers hydrogen use applications as wide range of industrial processes handling hydrogen.

In the sense of an intended use, awareness should be given to the applicability of the specifications in this document with regard to the selection of material, specific design considerations, specific manufacturing processes and final assessment (testing and inspection).

Furthermore, the requirements of EN 16668 and, in addition, those of the respective application standard as well as the relevant harmonized European valve standards listed in Annex A are considered.

The performance and life of valves that are exposed to hydrogen for long periods may be, among others, limited by material characteristics that increase the susceptibility of metals to absorption and permeation of hydrogen. To achieve an optimum between design life and service life of hydrogen-exposed valve components, detailed analysis of operating conditions, appropriate selection of materials, suitable valve design and effective quality control during all stages of engineering, processing and manufacturing are therefore recommended. effective maintenance and monitoring are additional factors to consider.

Material groups used in this document are according to CEN ISO/TR 15608, EN 12516-1:2014+A1:2018, Annex B, and EN 1092-1:2018, Annex B.

NOTE Further information on material groups and corresponding materials are provided in CEN ISO/TR 20172.

5 Hydrogen service (damage mechanisms)

5.1 Metallic materials

Table 1 summarizes the services considered in this document. It contains damage mechanisms caused by hydrogen (HEE, HTHA) or applications in combination with hydrogen which require additional measures.

NOTE In Table 1 the temperature of 170 °C as lower limit of HTHA considers a safety margin of 30 °C.

Table 1 — Summary of services

Service/damage mechanism	**Hydrogen in low temperature application**	**Hydrogen Environmental Embrittlement (HEE)** [a,c]	**High Temperature Hydrogen Attack (HTHA)**	**Hydrogen service with cyclic loads** [b] **(fatigue)**
Temperature	−253 °C ≤ *TS* < −150 °C	−150 °C ≤ *TS* < 170 °C	*TS* ≥ 170 °C	all
Hydrogen partial pressure	All pressures	p (H_2) > 1 bar	p (H_2) > 3,5 bar	p (H_2) > 1 bar

[a] HEE typically occurs up to a temperature of 150 °C. The temperature of 170 °C is specified to close the gap between HEE and HTHA.

[b] In accordance with EN 13445-3:2021, Clause 17 and 18.

[c] For nickel and nickel alloys HEE can also occur at temperatures above 170 °C.

5.2 Non-metallic materials

Non-metallic materials exhibit varying behaviour in the presence of hydrogen service. The damaging mechanisms in the presence of hydrogen are different from those for metallic materials.

Some general information has been included in Annex B.

6 General information on material selection for each hydrogen service (damage mechanism)

6.1 Hydrogen in low temperature applications

The proneness to brittle fracture of the selected materials shall be evaluated for the respective application.

For multiple process operation modes (e.g. H2 purging, cool-down, warm-up…), other requirements linked to HEE, HTHA damage mechanism that may apply shall be evaluated.

NOTE Hydrogen plants to low temperature covered by EN 13445, EN 13480, Annex B method 2 are in safe operation for years. The influence of hydrogen to the transition temperature is investigated in separate scientific projects.

Unless there is any other information available, a limitation to −40 °C (NL1) and to −50 °C (NL2) is considered sound engineering practice according to harmonized material standards for plates, pipes and forging.

6.2 Hydrogen environmental embrittlement (HEE)

6.2.1 General

Materials shall be selected for industrial valves intended for hydrogen applications.

In the following clauses, materials according to harmonized European material standards are considered.

6.2.2 Ferritic steels except austenitic ferritic stainless steels

Here are listed the main metallic materials:

a) Materials of group 1.1, 1.2 (3E0, 7E0, 7E1) and 1.2 (3E1, 8E2, 8E3):

— The nominal minimum yield strength shall be less than or equal to 370 MPa with a nominal minimum tensile strength less than or equal to 620 MPa as defined within the applicable material standard.

— Materials of group 1.1, 1.2 (3E0, 7E0, 7E1) and 1.2 (3E1, 8E2, 8E3) are suitable for hydrogen applications.

NOTE 1 Values for yield strength or tensile strength are nominal values as per material standard at room temperature.

b) Materials of group 5.1 (5E0), 5.2 (6E0) and 9.1 (7E2, 7E3): Materials belonging to these groups are suitable for hydrogen applications.

c) Material of group 6.3 (-) 20CrMoV13-5-5 (1.7779): Materials belonging to this group can be susceptible to hydrogen embrittlement and should be evaluated for application.

NOTE 2 More information can be found in Annex B, Table B.2.

d) Material of group 9.2 (7E3) namely 12Ni14 (1.5637) may be considered, provided the application temperatures do not exceed 50°C and no welding takes place on the parent material.

NOTE 3 The advice can also be found in Table B.2.

6.2.3 Austenitic stainless steels

Materials of group 8.1 (11E0, 12E0, 13E0, 13E1, 14E0, 15E0) and 8.2 (13E0) are suitable for hydrogen applications.

All materials of group 8.1 and 8.2 shall satisfactorily pass intergranular corrosion test (ICC) according to EN ISO 3651-2:1998, Method A.

NOTE The intergranular corrosion test can be replaced by other methods to demonstrate a proper micro-structure.

6.2.4 Austenitic-ferritic steels

Austenitic-ferritic steels of group 10.1 such as 1.4462 (16E0) are suitable for hydrogen applications if cold forming is below 5 %. During processing, strain-hardening shall be avoided.

6.2.5 Aluminium and aluminium alloys

Aluminium alloys as specified in EN 12516-4 are suitable for hydrogen dry environment applications otherwise additional provisions should be addressed. In case the aluminium alloy EN AW 6061 is used for welded constructions, it is susceptible to hydrogen embrittlement.

6.2.6 Cast irons

The use of cast iron containing lamellar graphite shall be avoided.

Ductile cast iron may be selected based on suitability evaluation if product and application standards provide for it.

6.2.7 Steel casting

Steel castings according to EN 10213 are suitable for hydrogen applications, whereby the requirements mentioned for the corresponding material groups in this document shall be considered.

Due to the nature of casting a higher porosity can be expected. Adverse effects of porosity (e.g. leakage) need to be considered. A sound casting design is crucial to enable foundries to achieve a high and reproducible casting quality, especially around large changes in thickness. Castings shall not be peened, plugged or impregnated.

NOTE Good manufacturing practice on casting quality and NDT can be found in EN 16668:2025, Annex E.

6.2.8 Copper and its alloys

Copper (material group 31 according to CEN ISO/TR 15608), and its alloys (material group 32-38 according to CEN ISO/TR 15608) can be embrittled in hydrogen gas due to a reaction between dissolved hydrogen and oxygen (either in solution or from oxides) to form water, resulting in pores that promote material failure. For this reason, the use of copper shall be limited to oxygen-free grades only. For copper alloys (material groups 32-38 according to CEN ISO/TR 15608), the effect of deoxidation and oxygen binding is achieved through alloying elements, so these material groups show no sensitivity to hydrogen.

The oxygen content shall be controlled so that the material conforms to the hydrogen embrittlement requirements in accordance with EN 1976.

Some copper and its alloys (i.e. bronze, brass) are specified in EN 12516-4.

NOTE More information on copper and its alloys can be found in EIGA IGC Doc 121/14 and ISO/TR 15916.