INTERNATIONAL STANDARD

ISO 19881

First edition
2018-10

Gaseous hydrogen — Land vehicle fuel containers

Hydrogène gazeux — Réservoirs de carburant pour véhicules terrestres

Reference number
ISO 19881:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee TC 197, *Hydrogen technologies*.

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.

Introduction

The purpose of this document is to promote the implementation of hydrogen powered land vehicles through the creation of performance based testing requirements for compressed hydrogen fuel containers. The successful commercialization of hydrogen land vehicle technologies requires standards pertaining to fueling stations, vehicle fuel system components and the global homologation of standards requirements for technologies with the same end use. This will allow manufacturers to achieve economies of scale in production through the ability to manufacture one product for global use.

This document is based on the CSA Standard ANSI/HGV 2-2014.

Gaseous hydrogen — Land vehicle fuel containers

1 Scope

This document contains requirements for the material, design, manufacture, marking and testing of serially produced, refillable containers intended only for the storage of compressed hydrogen gas for land vehicle operation. These containers

a) are permanently attached to the vehicle,

b) have a capacity of up to 1 000 l water capacity, and

c) have a nominal working pressure that does not exceed 70 MPa.

The scope of this document is limited to fuel containers containing fuel cell grade hydrogen according to ISO 14687 for fuel cell land vehicles and Grade A or better hydrogen as per ISO 14687 for internal combustion engine land vehicles. This document also contains requirements for hydrogen fuel containers acceptable for use on-board light duty vehicles, heavy duty vehicles and industrial powered trucks such as forklifts and other material handling vehicles.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 306, *Plastics — Thermoplastic Materials — Determination of Vicat Softening Temperature (VST)*

ISO 7866:2012, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*

ISO 9809-1:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

ISO 9809-2:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 11439:2013, *Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles*

ISO 19078:2013, *Gas cylinders — Inspection of the cylinder installation, and requalification of high pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles*

ISO 19882, *Gaseous hydrogen — Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D2344/D2344M-00, *Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates*

ASTM D3359, *Standard Test Methods for Measuring Adhesion by Tape Test*

ASTM D3418, *Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry*

ASTM D4138, *Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross Sectioning Means*

ASTM D4814, *Standard Specification for Automotive Spark-Ignition Engine Fuel*

ASTM D7091, *Standard Practice for Nondestructive Measurement of Fry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals*

ASTM E8/E8M, *Standard Test Methods for Tension Testing of Metallic Materials*

ASTM E23, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

ASTM G154-12, *Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*

CGA C-1-2009, *Methods for Pressure Testing Compressed Gas Cylinders*

CGA C-6.4, *Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Gas Vehicle (HGV) Fuel Containers and Their Installations*

SAE J2579:2013, *Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles*

SAE J2601, *Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles*

UN GTR No. 13, *UN Global Technical Regulation on Hydrogen and Fuel Cell Vehicles*

3 Terms and definitions

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

ISO and IEC maintain terminological 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
autofrettage
pressure application procedure, used in manufacturing composite containers with metal *liners* (3.14), which strains the *liner* (3.14) past its yield point sufficiently to cause permanent plastic deformation that results in the *liner* (3.14) having residual compressive stresses and the fibers having residual tensile stresses at zero internal pressure

3.2
burst pressure
highest pressure reached in a container during a burst test

3.3
composite
filament and resin system

3.4
container category
unique class of containers that are intended for a specific usage

3.4.1
Category A
class of containers that are intended to be used in light duty and heavy duty land vehicle applications, regardless of the potential for further qualification to the UN GTR No. 13 for hydrogen and fuel cell vehicles

3.4.2
Category B
class of *Type 4* (3.5.4) containers of 70 MPa nominal working pressure that are intended to be further qualified in accordance with the UN GTR No. 13 for hydrogen and fuel cell vehicles with a gross vehicle mass of 4 536 kg or less

3.4.3
Category C
class of containers that are intended to be used on hydrogen powered industrial trucks

3.5 Container type

3.5.1
Type 1
metal container

3.5.2
Type 2
container which contains a metal *liner* (3.14) reinforced with a resin impregnated continuous filament (hoop-wrapped)

Note 1 to entry: See 3.11.

3.5.3
Type 3
container which contains a metal *liner* (3.14) reinforced with a resin impregnated continuous filament (fully-wrapped)

Note 1 to entry: See 3.10.

3.5.4
Type 4
container which contains a resin impregnated continuous filament with a nonmetallic *liner* (3.14) (all composite)

Note 1 to entry: See 3.3.

3.6
design family
group of containers consisting of one fully qualified design and variations on that design that comply with Table 6

3.7
destroyed
in a state of alteration which makes a container physically unusable for its purpose

3.8
dry hydrogen
hydrogen which meets or exceeds the quality level in ISO 14687

3.9
fold
place where two material flows meet in such a manner as to create a sharp visual groove

3.10
full-wrapped
reinforced by a *composite* (3.3) material applied over the entire *liner* (3.14) including the domes

3.11
hoop-wrapped
reinforced by a *composite* (3.3) material applied in a substantially circumferential pattern over the cylindrical portion of the *liner* (3.14) so that the filament does not transmit any significant stresses in a direction parallel to the container longitudinal axis

3.12
leakage
release of contents through a defect or crack

3.13
leak test gas
gas for testing leaks that consists of *dry hydrogen* (3.8), dry helium or blends that contain these gases at a detectable level

Note 1 to entry: Use leak test gas in 9.3.

3.14
liner
inner gas tight container or gas container to which the overwrap is applied

3.15
maximum fueling pressure
MFP
maximum pressure applied to a compressed system during fueling

Note 1 to entry: The maximum fueling pressure is 125 % of the *nominal working pressure* (3.18).

3.16
minimum required burst pressure
minimum *burst pressure* (3.2) that is to be met during a burst test and which is needed to demonstrate the required *stress ratio* (3.26)

3.17
normal cubic centimeter
Ncc
dry gas that occupies a volume of 1 cm^3 at a temperature of 273,15 K (0 °C) and an absolute pressure of 101,325 kPa (1 atm)

3.18
nominal working pressure
container pressure, as specified by the container manufacturer, at a uniform gas temperature of 15 °C and full gas content

3.19
permanently attached
intended to remain fixed to a particular vehicle for the lifetime of the container or vehicle, whichever comes first

3.20
permeation
diffusion of the gaseous contents to the atmosphere at a molecular level, by means of pores or molecular gaps

3.21 Pressures

3.21.1
autofrettage pressure
pressure to which a container is taken with the intent of yielding the *liner* (3.14) or inner surface of the container

Note 1 to entry: The autofrettage operation is considered to be part of the manufacturing operation and is conducted prior to proof testing.

3.21.2
fill pressure
pressure attained at the actual time of filling

Note 1 to entry: Fill pressure varies according to the gas temperature in the container, which is dependent on the filling parameters and the ambient conditions. The maximum fill pressure should not exceed 125 % of the *nominal working pressure* (3.18).

3.21.3
hydrostatic pressure
pressure to which a container is taken during acceptance testing

Note 1 to entry: See 17.3.5.

3.22
pressure relief device
PRD
device that, when activated under specified performance conditions, is used to vent the container contents

3.23
rejectable damage
damage as outlined in ISO 19078 or CGA C-6.4 and in agreement with the container manufacturer's recommendations

3.24
rupture
sudden and unstable damage propagation in the structural components of the container resulting in loss of contents

3.25
settled temperature
uniform gas temperature after any change in the temperature caused by filling has dissipated

3.26
stress ratio
minimum ultimate strength of the fiber, as determined in pressure container burst tests, divided by the stress in the fiber at the *nominal working pressure* (3.18)

4 Service conditions

4.1 General

4.1.1 Standard service conditions

The standard service conditions specified herein are provided as a basis for the design, manufacture, inspection, testing and approval of containers that are to be mounted permanently on vehicles and used to store compressed hydrogen for use as a fuel on-board the vehicles. Containers are intended to be installed on vehicles in accordance with SAE J2578, SAE J2579, IEC 62282-4-101, UN GTR No. 13, or other equivalent standards.

4.1.2 Category

Category A, Category B and Category C containers are intended to provide a sufficient level of safety for the intended application, but test methods and records are different.

4.1.3 Service life

The service life for the containers shall be specified by the container manufacturer. The specified life shall not be less than 10 years or greater than 25 years as defined in 4.3.

4.1.4 Periodic in-service inspections

Any requirements and procedures for periodic re-qualification by inspection or testing during the service life shall be specified by the container or vehicle manufacturer on the basis of use under the service conditions specified herein. For containers that require periodic re-qualification by inspection or testing, the container label shall identify this requirement according to Clause 15. Guidance on periodic inspection is included in Annex A.

4.2 Pressures

4.2.1 Nominal working pressures

This document applies to containers that have a nominal working pressure, as specified by the container manufacturer, of 25 MPa, 35 MPa, 50 MPa or 70 MPa at 15 °C, hereinafter referred to in this document as the following:

a) “H25” — 25 MPa;

b) “H35” — 35 MPa;

c) “H50” — 50 MPa;

d) “H70” — 70 MPa.

4.2.2 Maximum pressures

Containers are designed to be filled to a pressure not exceeding any of the following conditions:

a) A pressure that would settle to the nominal working pressure at a settled temperature of 15 °C. The fill pressure shall be temperature compensated to prevent pressures from exceeding the maximum pressures that are defined.

b) Normally up to 125 % of the nominal working pressure immediately after filling, regardless of the gas temperature, and infrequently up to 150 % under dispenser fault conditions.

4.3 Maximum number of filling cycles

Containers are designed to be filled to pressures not exceeding the requirements of 4.2.2, as follows:

a) Category A:

For a maximum of 750 times the service life of the container in years for a minimum of 10 years and a maximum of 25 years.

b) Category B:

For a maximum of 5 500, 7 500, or 11 000 for a 15 year service life.

c) Category C:

For a maximum of 1 125 times the service life of the container in years for a minimum of 10 years and a maximum of 25 years.

NOTE 1 Refer to D.3, D.4, and D.5 for the rationale on container fill cycles.

NOTE 2 Containers are expected to be removed from service when the service life used in the design qualification has expired, consistent with the labelling requirements in Clause 15.

4.4 Temperature range

4.4.1 Settled gas temperatures

Settled temperature of the gas in containers may vary from −40 °C to 85 °C.

4.4.2 Container temperatures

The temperature of the container materials may vary from −40 °C to 85 °C.

4.4.3 Transient gas temperatures

Transient gas temperatures (temperatures that would be insufficient to change the bulk temperature of the liner material) during filling and discharge may vary beyond the limits described in 4.4.1. Containers qualified to meet this document shall be capable of being filled safely utilizing SAE J2601 fueling protocol or an equivalent fueling protocol.

4.4.4 Test temperatures

Unless otherwise specified, all tests shall be conducted at an ambient temperature of 20 °C ± 5 °C.

4.5 Gas composition

Containers made according to this document are designed to be used with hydrogen fuel complying with ISO 14687 or SAE J2719. Containers made according to this document can also be used for hydrogen road vehicles with hydrogen fuel (Type I Grade A) complying with ISO 14687.

4.6 External surfaces

Container external surfaces shall be designed to be resistant to environmental conditions outlined in 17.3.3.

4.7 Installation requirements

The container manufacturer shall provide information to the vehicle manufacturer or system integrator as necessary to support proper installation in the vehicle.

The vehicle manufacturer or system integrator shall be responsible for the protection of the container, container valves, pressure relief devices and connections as required.

If this protection is mounted to the container, the design and method of attachment shall be approved by the container manufacturer. Factors to be considered include the ability of the container to support the transferred impact loads and the effect of local stiffening on container stresses and fatigue life.

Containers shall be protected from accidental cargo spillage and from mechanical damage. This document contains no requirements for container integrity in a vehicle collision. Container locations and mountings should be designed to provide adequate impact protection to prevent container failure in a collision.