DRAFT INTERNATIONAL STANDARD ISO/DIS 15869-1

ISO/TC **197** Secretariat: **SCC**

Voting begins on **2004-01-15** Voting terminates on **2004-06-15**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Gaseous hydrogen and hydrogen blends — Land vehicule fuel tanks —

Part 1:
General requirements

Hydrogène gazeux et mélanges d'hydrogène gazeux — Réservoirs de carburant pour véhicules terrestres — Partie 1: Exigences générales

ICS 43.060.40; 71.100.20

Member bodies are reminded to consult relevant national interests in each of the technical fields concerned [*Hidrogen technologies* (ISO/TC 197), *Gas cylinder* (ISO/TC 58/SC 3) and *Road vehicles* (ISO/TC 22) and before returning their ballot to the Central Secretariat.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

International Standard ISO 15869-1 was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*, and Technical Committee ISO/TC 58 Subcommittee SC 3, *Gas cylinder design.*

This is the first edition.

ISO 15869 consists of the following parts, under the general title *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks*:

— *Part 1: General requirements*

— *Part 2: Particular requirements for metal tanks (type 1)*

— *Part 3: Particular requirements for hoop wrapped composite tanks with a metal liner (type 2)*

— *Part 4: Particular requirements for fully wrapped composite tanks with a metal liner (type 3)*

— *Part 5: Particular requirements for fully wrapped composite tanks with a non-metallic liner (type 4)*

Introduction

Tanks for the on-board storage of compressed gaseous hydrogen and hydrogen blends as fuels for land vehicle service are required to be light-weight, at the same time maintaining or improving on the level of safety currently existing for other pressure vessels. These requirements are achieved by:

a) specifying service conditions precisely and comprehensively as a firm basis for both tank design and use;

b) using an appropriate method to assess cyclic pressure fatigue life and to establish allowable defect sizes in metal tanks or liners;

c) requiring design qualification tests;

d) requiring non-destructive testing and inspection of all production tanks;

e) requiring destructive tests on tanks and tank material taken from each batch of tanks produced;

f) requiring manufacturers to specify recommended periodic re-inspection and, if necessary, retesting requirements; and

g) requiring manufacturers to specify as part of their design, the safe service life of their tanks.

Designs meeting the requirements of ISO 15869:

a) will have a fatigue life which exceeds the service life specified;

b) when pressure cycled to failure, will leak but not rupture; and

c) when subject to hydrostatic burst tests, will have factors of “stress at burst pressure” over “stress at working pressure” that exceed the values specified for the type of design and the materials used.

Owners or users of tanks designed to ISO 15869 should note that the tanks are designed to operate safely if used in accordance with specified service conditions for a specified finite service life only. The expiry date is marked on each tank and it is the responsibility of owners and users to ensure tanks are not used after that date, and are inspected in accordance with the manufacturer’s instructions throughout the specified service life.

Gaseous hydrogen and hydrogen blends — Land vehicule fuel tanks —

Part 1:
General requirements

1 Scope

This International Standard specifies minimum requirements for serially produced light-weight refillable gas tanks intended only for the on-board storage of high pressure compressed gaseous hydrogen or hydrogen blends as fuels for land vehicles to which the tanks are to be fixed.

This International Standard covers tanks of any steel, aluminium or non-metallic material construction, using any design or method of manufacture suitable for the specified service conditions.

This part of ISO 15869 defines the common aspects of all tanks covered in ISO 15869. Specific aspects, which may modify or supplement the common aspects and therefore cannot stand alone, are given in the following individual parts:

— Type 1 - Metal tanks in ISO 15869-2;

— Type 2 - Hoop wrapped composite tanks with a metal liner in ISO 15869-3;

— Type 3 - Fully wrapped composite tanks with a metal liner in ISO 15869-4;

— Type 4 - Fully wrapped composite tanks with non-metallic liner in ISO 15869-5.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15869. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15869 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat Softening Temperature (VST)*

ISO 527-2:1993, *Plastics — Determination of tensile properties —Part 2: Test conditions for moulding and extrusion plastics (incorporating Technical Corrigendum 1: 1994)*

ISO 2808:1997, *Paints and varnishes — Determination of film thickness*

ISO 4624:1978, *Paints and varnishes — Pull-off test for adhesion*

ISO 6505-1:1999, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 7225, *Precautionary labels for gas cylinders*

ISO 7866:1999, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*.

ISO 9809-1:1999, *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 9809-2:2000, *Gas cylinders* – De*sign, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 11114-4:-[1)] , Transportable gas cylinders — Compatibility of cylinders and valve materials with gas contents — Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement

ISO 11439:2000, *High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles*

ISO 14687:1999/Cor 1:2001, *Hydrogen fuel - Product specification*

ISO 15869-2: *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks — Part 2: Particular requirements for metal tanks*

ISO 15869-3: *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks — Part 3: Particular requirements for hoop wrapped composite tanks with a metal liner*

ISO 15869-4: *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks — Part 4: Particular requirements for fully wrapped composite tanks with a metal liner*

ISO 15869-5: *Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks — Part 5: Particular requirements for fully wrapped composite tanks with a non-metallic liner*

ASTM B117-90, *Test Method of Salt Spray (Fog) Testing*

ASTM D522-92, *Mandrel Bend Test of Attached Organic Coatings*

ASTM D1308-87, *Effect of Household Chemicals on Clear and Pigmented Organic Finishes*

ASTM D2344/D2344M-00[E1], *Test Method for Apparent Interlaminar Shear Strength of Parallel Fibre Composites by Short Beam Method*

ASTM D2794-92, *Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)*

ASTM D3170-87, *Chipping Resistance of Coatings*

ASTM D3418-97, *Test Method for Transition Temperatures of Polymers by Thermal Analysis*

ASTM G154-00a, *Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-metallic Materials*

3 Terms and definitions

For the purposes of this part of ISO 15869, the following terms and definitions apply.

3.1
auto-frettage
a pressure application procedure used in manufacturing composite tanks with metal liners, which strains the liner past its yield point, sufficiently to cause permanent plastic deformation

NOTE This results in the liner having compressive stresses and the fibres having tensile stresses at zero internal pressure.

1) To be published.

3.2
auto-frettage pressure
the pressure within the over-wrapped composite tank at which the required distribution of stresses between the liner and the over-wrap is established

3.3
batch of composite tanks
a group of not more than 200 tanks plus tanks for destructive testing, or if greater, one shift of successive production of tanks, successively produced from qualified liners having the same size, design, specified materials of construction and process of manufacture

3.4
batch of metal tanks/liners
a group of not more than 200 tanks/liners plus tanks/liners for destructive testing, or if greater, one shift of successive production of metal tanks/liners, successively produced having the same nominal diameter, wall thickness, design, specified material of construction, process of manufacture, equipment for manufacture and heat treatment, and conditions of time, temperature and atmosphere during heat treatment

3.5
batch of non-metallic liners
a group of not more than 200 liners plus liners for destructive testing, or if greater, one shift of successive production of non-metallic liners, successively produced having the same nominal diameter, wall thickness, design, specified material of construction and process of manufacture

3.6
burst pressure
highest pressure reached in a tank during a burst test

3.7
composite tank
a tank made of resin impregnated continuous filament wound over a liner

3.8
controlled tension winding
a process used in manufacturing hoop-wrapped composite tanks with metal liners by which compressive stresses in the liner and tensile stresses in the over-wrap at zero internal pressure are obtained by winding the reinforcing filaments under significant high tension

3.9
design change
any change in the selection of structural materials or dimensional change not attributable to normal manufacturing tolerances

3.10
filling pressure
pressure to which a tank is filled at the time of filling

NOTE Filling pressure varies according to the gas temperature in the cylinder, which is dependent on the charging parameters and the ambient conditions.

3.11
finished tanks
completed tanks which are ready for use, typical of normal production, complete with identification marks and external coating including integral insulation specified by the manufacturer, but free from non-integral insulation or protection

3.12
fully-wrapped composite tank
tank with an over-wrap having a filament wound reinforcement both in the circumferential and axial direction of the tank

3.13
gas temperature
the temperature of gas in a tank

3.14
hoop-wrapped composite tank
tank with an over-wrap having a filament wound reinforcement in a substantially circumferential pattern over the cylindrical portion of the liner so that the filament does not carry any significant load in a direction parallel to the tank longitudinal axis

3.15
hydrogen blend
a mixture of natural gas and hydrogen

3.16
liner
container that is used as a gas-tight, inner shell, on which reinforcing fibres are filament wound to reach the necessary strength

3.17
manufacturer
the person or organization responsible for the design, fabrication and testing of the tanks

3.18
over-wrap
the reinforcement system of filament and resin applied over the liner

3.19
prestress
the process of applying auto-frettage or controlled tension winding

3.20
service life
the life in years during which the tanks may safely be used in accordance with the standard service conditions

3.21
settled pressure
the gas pressure when a given settled temperature is reached

3.22
settled temperature
the uniform gas temperature after any change in temperature caused by filling has dissipated

3.23
stress ratio
stress in the fibre at the specified minimum burst pressure divided by the stress in the fibre at working pressure

3.24
test pressure
required pressure applied during a pressure test

3.25
usage monitoring and control system (UMCS)
electronic system that counts the filling cycles of the tank and prevents further use of the vehicle when a predetermined number of filling cycles is exceeded

3.26
working pressure
the settled pressure at a uniform temperature of 15 °C

4 Service conditions

4.1 General

The service conditions specified in this part of ISO 15869 are provided as the basis for the design, manufacture, inspection, and testing of tanks that are to be mounted permanently on land vehicles and used to store compressed gaseous hydrogen or hydrogen blends at ambient temperatures for use as a fuel on these vehicles.

The service conditions specified are also intended to provide information on how tanks made to ISO 15869-2, ISO 15869-3, ISO 15869-4 and ISO 15869-5 may safely be used, to:

a) manufacturers of tanks;

b) owners of tanks;

c) designers or contractors responsible for the installation of tanks;

d) designers or owners of equipment used to refuel land vehicle tanks;

e) suppliers of gaseous hydrogen and hydrogen blends; and

f) regulatory authorities that have jurisdiction over tank use.

The service conditions do not cover external loadings that may arise from vehicle collisions, etc.

4.2 Service life

The service life for which tanks are safe shall be specified by the tank manufacturer on the basis of use under service conditions specified herein. The maximum service life shall be 20 years.

4.3 Working pressure

The working pressure for which tanks are safe shall be specified by the tank manufacturer on the basis of use under service conditions specified herein. The working pressure shall be specified for gaseous hydrogen and hydrogen blends settled at a temperature of 15 °C.

4.4 Maximum filling pressure

Tanks shall be designed to be filled up to a maximum pressure which does not exceed 1,25 times the working pressure, regardless of filling conditions or temperature, and which settle to a pressure not greater than the working pressure at the settled temperature of 15 °C.

4.5 Filling cycles

4.5.1 General

Tanks shall be designed to be filled up to a number of filling cycles of 5000 cycles, except as permitted in 4.5.2 and 4.5.3.

NOTE The number of 5000 filling cycles was established based on the assumption that the tank would be filled up once per day for a maximum service life of 15 years.

4.5.2 Extended number of filling cycles

The vehicle manufacturer may specify an extended number of filling cycles for a tank design based on the design lifetime mileage of the vehicle and range with maximum fuel capacity. The extended number of fillings shall be calculated as follows, but it shall not be less than 5000 cycles.

$$F = \frac{L}{R}$$

where: F is the extended number of filling cycles;

L is the design lifetime mileage of the vehicle;

R is the range with maximum fuel capacity.

4.5.3 Reduced number of filling cycles

Provided that a usage monitoring and control system (UMCS) is to be used in conjunction with the tank, the number of filling cycles for tanks may be less than 5000 cycles. The reduced number of filling cycles shall be specified by the tank manufacturer and shall vary with different applications based on the design lifetime mileage of the vehicle and range with maximum fuel capacity. The UMCS shall prevent any further use of the vehicle when the specified number of filling cycles is exceeded, until the tanks that have exceeded that value are replaced with new tanks.

Details on the safety concept of the UMCS are provided in Annex E.

4.6 Gas temperature

Tanks shall be designed to be suitable for use in an average gas temperature between –40 °C and 85 °C in normal conditions including filling and discharging.

4.7 Tank temperature

Tanks shall be designed to be suitable for the following material temperature limits: –40 °C to 85 °C.

4.8 Gas composition

Tanks shall be designed to be filled with compressed gaseous hydrogen and hydrogen blends containing more that 2% hydrogen by volume.

Compressed hydrogen gas shall comply with, or be of greater purity than, Type 1, Grade A gas composition in ISO 14687:1999/Cor 1:2001.

Compressed natural gas used in hydrogen blends may vary as stated in the dry gas composition limits specified in ISO 11439:2000.