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Gaseous hydrogen -- Fuelling stations -- Part 6: Fittings

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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.

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. 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. 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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 197.

Introduction

This document will facilitate the development of hydrogen infrastructure that is needed to pave a way for the widespread deployment of hydrogen-fuelled vehicles. The successful commercialization of hydrogen vehicle technologies requires codes and standards pertaining to fuelling stations, vehicle fuel system components, and the global homologation of standards requirements for technologies with the same end use. Essentially this will allow manufacturers to achieve economies of scale by producing one product for use globally.

International harmonization contributes to reducing technical barriers and stimulates related markets. The development of a suite of standards that address hydrogen gas vehicles and fuelling stations is required. These standards will provide internationally homologized minimum safety performance criteria at the component level, thus providing a foundation to build a safe “fuelling system.”

This International Standard provides requirements for gaseous hydrogen fittings used in fuelling station service.

This document is based on the Canadian Standards Association reference CSA HGV 4.10 *Fittings for compressed hydrogen gas and hydrogen rich gas mixtures*. This document is not intended to exclude any specific technologies that meet the performance requirements herein.

This document is to be applied in conjunction with other International Standards relevant to hydrogen fuelling stations and components.

Gaseous hydrogen -- Fuelling stations -- Part 6: Fittings

1 Scope

This document specifies uniform methods for testing and evaluating the performance of fittings, including connectors and stud ends for ports, used with compressed hydrogen gas in hydrogen fuelling station applications. It does not address special requirements for liquid and slush hydrogen.

In this document, the term “fittings” includes fittings, connectors, and stud ends for ports. See Figure 1.

This document does not apply to stand alone components, such as:

1. Quick Action couplings, (i.e., quick connects);

2. Fittings which are integral to stand-alone components, e.g., valves described in ISO 19880-3; devices covered in SAE J2600; Compressed Hydrogen Surface Vehicle Refueling Connection Devices; ISO 17268, Gaseous hydrogen land vehicle refuelling connection devices; and ANSI/CSA HGV-4.4, Breakaway devices for compressed hydrogen dispensing hoses and systems

3. Flanges; or

4. Welded or brazed joints.

Fittings which are integral to stand-alone components are qualified per the specification for the stand-alone component.

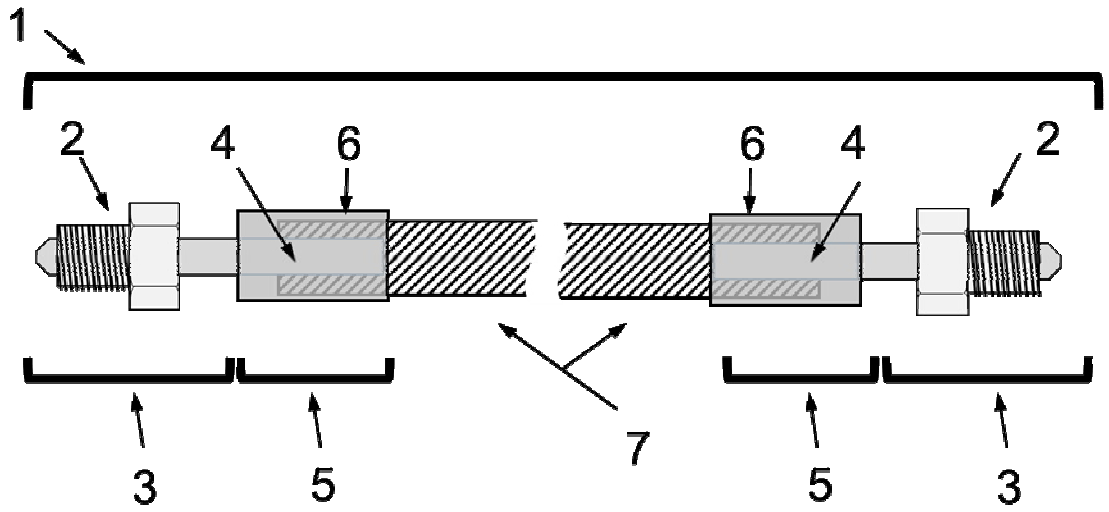
Example: Hose assemblies

NOTE 1

ISO 19880-5 has been developed primarily for hoses and hose assemblies for dispensing high pressure hydrogen from refuelling dispensers to hydrogen vehicles. Hose assemblies include the hose with connectors on each end (see Figure 1). Each connector has two basic functional elements that are addressed as described below:

1) Coupling to hose. This function is defined by requirements and verified (along with the hose itself) by performance-based tests in this document.

2) Fitting for transition and connection to the piping system or equipment. This function is addressed by reference to appropriate hydrogen equipment standards and piping codes.



Key

1 hose assembly
2 mechanical joint
3 fitting
4 nipple
5 coupling
6 crimped socket
7 hose

Figure 1 —Hose assembly and fitting

This document applies to newly manufactured fittings. It does not apply to fittings previously qualified for hydrogen service by other relevant Nationally Recognized standards or regulations such as AFNOR, BSI, CGA, JIS, etc.

All references to pressure throughout this document are to be considered gauge pressures, unless otherwise specified.

All dimensions used in this document are in metric units [International System of Units (SI)], unless otherwise specified. If a value for a measurement, as given in this document, is followed by an equivalent value in other units, the first stated is to be regarded as the specification.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Unless otherwise noted, the latest publications of the referenced documents

shall be used.

ASTM F1387-2005 Performance of Piping and Tubing Mechanically Attached Fittings

IEC 60204-1:2016: Safety of machinery - Electrical equipment of machines - Part 1: General requirements

ISO 6605 Hydraulic fluid power – Test Methods for hoses and hose assemblies

ISO 6743-4 Lubricants, industrial oils and related products (class L) -- Classification -- Part 4: Family H (Hydraulic systems)

ISO 14687-2:2012: Hydrogen fuel -- Product specification -- Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles

ISO 19880-1: Gaseous Hydrogen – Fuelling Stations — Part 1: General requirements

ISO 19880-3: Gaseous Hydrogen – Fuelling Stations – Part 3: Valves

ISO 19880-5: Gaseous Hydrogen – Fuelling Stations – Part 5: Hoses and Hose Assemblies

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 19880-1 and the following apply.

3.1
normal cm3/hr
volume measured over time measured at normal conditions of 0degC and 1 atmosphere, in cubic centimeters per hour.

3.2
fitting
device that connects tubes, hoses, or pipes to each other or to other system components

3.3
fitting assembly
fitting assembled to a mating tube, pipe, hose, or system component

3.4
hydrogen test gas
gas whose composition complies with SAE J2719, or ISO 14687, used as the test medium

3.5
pipe
hollow tubular product conforming to the dimensional requirements for nominal pipe size (NPS) as tabulated in ANSI B36.10 Welded and Seamless Wrought Steel Pipe, Table 2

3.6
rated pressure
the manufacturer's specified in-service internal pressure assigned to a mechanically attached fitting assembly. This value includes a maximum and minimum pressure. If no minimum pressure is stated, it is assumed to be atmospheric pressure

3.7
rated pressure/temperature envelope
the manufacturer's specified in-service pressure and temperature operating ranges assigned to a fitting assembly

3.8
rated temperature
the manufacturer's specified in-service temperature assigned dependent on the temperature envelope to a fitting assembly. This value includes a maximum and minimum temperature. If no minimum temperature is stated, it is assumed to be -40°C. If no maximum temperature is stated, it is assumed to be 85°C.

3.9
system component
individual unit (for example, cylinder, valve, filter, but excluding piping) comprising one or more parts designed to be a functional part of a fluid system

3.10
test pressure
a selected pressure used during testing that is based on the rated pressure of the fitting assembly, the pipe, or tube; whichever is lower, multiplied by the factor specified for each test

3.11
test sample
a fitting assembly used for testing

4 General Requirements

4.1 General

The requirements of this standard may be superseded by an application specific standard.

The construction of parts not covered by this document shall be in accordance with reasonable concepts of safety, substantiality and durability.

All specifications as to construction may be satisfied by the requirements prescribed herein or in such a way as to provide at least equivalent performance.

Requirements for end fittings attached to hoses (hose assemblies) are found in ISO 19880-5.

4.1.1 Safety Analysis

Design safety analysis, such as Failure Modes and Effects Analysis (FMEA) and Process Failure Modes and Effects Analysis, shall be performed for fittings. The documents shall be made available for review on request to the certifying body.

NOTE: FMEA is a methodology used in industry to identify potentially hazardous failure modes of safety devices and recommend changes in design, manufacturing, inspection, and/or testing that eliminate such failure modes or minimize their effects. FMEA is applied to both device design and to the manufacturing and assembly process to identify corrective actions that improve device reliability and safety. Available references include SAE J1739, “Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), and Potential Failure Mode and Effects Analysis for Machinery (Machinery FMEA)”.

4.2 Intended Use

4.2.1 Hydrogen fuel quality

The quality of hydrogen fuel dispensed to vehicles is defined in ISO 14687. The design, manufacture and operation of fittings constructed in accordance with this document shall not introduce contamination to the hydrogen passing through or in contact with them.

4.2.2 Pressure rating

The pressure rating of the fittings shall be equal to or above the dispenser pressure ratings. For further

information regarding the relationships between pressure terms, see ISO 19880-1.

4.3 Material Requirements

4.3.1 General

Materials shall be selected to minimize the risk of significant change in performance due to hydrogen embrittlement, stress corrosion, or hydrogen-induced fatigue failure during the service life of the fitting.

4.3.2 Material restrictions

The following materials shall not be used:

Cast iron, malleable iron, and gray iron due to possibility of porosity of these materials in the context of the permeability of hydrogen,
Aluminium."

Note 1:
Aluminium is typically used for other components such as hydrogen ambient air vaporizers, cylinder bosses or valve bodies.

Note 2:
Contact between dissimilar metals should be avoided to prevent galvanic corrosion. When an electrolyte is expected to be present, dissimilar metals between tubing, fittings and other components should not be used. Anodic metals should not contact cathodic metals. Metal fittings should be compatible with metal tubing materials.

4.3.3 Electrical Bonding

The selection of materials and design shall ensure electrical bonding per IEC 60204-1.

4.4 Product Quality

4.4.1 General

The manufacturer shall establish production processes with quality control measures to ensure that production fittings meet requirements established in this document. As part of this requirement, a hydraulic proof pressure test at 150 % of the component pressure rating shall be conducted. Alternatively a gas leak test at 125 % of the component pressure rating may be conducted.

4.4.2 Manufacturing and Production Tests

Manufacturing and production tests are intended to provide minimum quality control standards for the fitting.

4.4.3 Records

The manufacturer shall establish documentation which describes the programs and procedures specified in Sections 4.4.4, and 4.4.5. The records shall be kept by the manufacturer in accordance with

the manufacturers' quality measures described in Section 4.4.1.

4.4.4 Traceability

The manufacturer shall use a program to qualify raw materials, parts, assemblies and purchased components and provide traceability of all components (manufacture or purchased) used in the production of devices.

4.4.5 Sampling Plan

A sampling plan, selection of tests, and the frequency of the tests, shall be mutually agreed upon by the manufacturer and the certifying agency.

4.4.6 Test Methods

The manufacturer's test method(s) shall specify the applicable tests described in this document.

4.4.7 Results

The results of these tests and the program outlined in Section 4.4.2 shall be recorded and maintained by the manufacturer for review by the certifying agency.

5 General Test Methods

5.1 General

5.1.1 Testing periods

Tests shall be conducted on the initial design and at any time changes are made in the design, material, or manufacturing process that could degrade the performance of mechanically attached fittings.

5.1.2 Acceptance

All fittings evaluated for continuous operation shall perform as intended without failure for the required number of cycles.

5.1.3 Agreement

Unless otherwise specified, the number of samples and order of applicable tests shall be mutually agreed upon by the manufacturer and the certifying body.

5.1.4 Waivers

Tests specified to establish the acceptance of a material for use in a fitting may be waived by the certifying body when acceptable evidence in the form of a declaration, supplied by the manufacturer of the material, to substantiate its suitability for use in the expected environment, is submitted by the

applicant.

5.2 Test Conditions

All tests shall be conducted over the range of sizes being qualified by the manufacturer. Interpolation of sizes bounded by fitting sizes previously tested with similar design and appropriate calculations shall be permitted.

5.2.1 Test Sample

5.2.1.1 Assembly Instructions

A fitting assembly shall be assembled in accordance with manufacturer's instructions.

5.2.1.2 Intermediate Fitting Sizes

At least one intermediate size shall be tested if the minimum and maximum pipe or tube outside diameter to be tested is equal to or greater than two." Through reasonable interpolations between fitting sizes tested, all other sizes of fittings within the same type, grade (or combination of grades), and class shall be considered acceptable if the fittings pass all of the testing requirements specified.

5.2.2 Pressure

Fittings shall be tested at the pressures to which they are rated. The ratings shall be stipulated in the manufacturers' literature.

5.2.3 Normal test temperature

Fittings shall be tested at the temperatures to which they are rated. The ratings shall be stipulated in the manufacturers' literature.

5.2.4 Specified test temperature

Unless stated otherwise, the tests specified herein shall be conducted at 20°C ± 5°C.

5.2.5 Test Media

5.2.5.1 General

Unless otherwise specified, tests shall be conducted using hydrogen as the test gas.

Proper care should be exercised when working with hydrogen gas.

5.2.5.2 Purging

Prior to testing with hydrogen gas, the fitting assembly shall be purged with nitrogen, helium, or another non-reactive gas and then seal.

5.2.6 Test sequence

The test sequence shall be as agreed between supplier and testing agency.

5.3 Design Qualification Tests

5.3.1 General

Design Qualification Tests are one-time tests used to qualify the design for a specific size, material, operating temperature, and pressure envelope.

NOTE: The term "Type Test" is sometimes used to mean one-time design qualification test.

If there is evidence of a fault in carrying out a test or an error in measurement, another test shall be performed. If the results of this test are satisfactory, the results of the prior test shall not be a basis for rejection.

5.3.2 External Leak Test

5.3.2.1 Objective

The objective of this test is to demonstrate the ability of the fitting assembled upon the tube or pipe to contain the test gas.

5.3.2.2 Method of Test

5.3.2.2.1 Pre Test

Prior to conditioning, purge the fitting assembly with nitrogen, or another non-reactive gas and then seal it at 30 percent of rated pressure using the hydrogen test gas.

Allow the test sample and test gas to stabilize to 20°C ± 5°C.

The test sample shall either be bubble free or have a leakage rate less than 10 normal cm^3/hr, (cubic centimeter normal per hour); (0.6 cu.in. N/hr) (cubic inches normal per hour).

5.3.2.2.2 Test Conditions

Three samples shall be tested. Each sample shall be tested at three sets of test conditions, defined below.

The test is to be conducted at two pressures for each of three temperatures in the order shown below:

A. Laboratory ambient temperature, 20°C ± 5°C:

- 10 bar (145 psi) or 10 percent of rated pressure, whichever is less; and
- 150 percent rated pressure.

B. Low Temperature - minimum rated temperature or -40°C:

- 10 bar (145 psi) or 10 percent of rated pressure, whichever is less; and
- 150 percent rated pressure.

C. High Temperature - maximum rated temperature, or 85°C:

- 10 bar (145 psi) or 10 percent of rated pressure, whichever is less; and
- 150 percent rated pressure.

The test is conducted by:

1. Placing the test sample into a temperature chamber and allowing the assembly to stabilize at the appropriate test temperature, as described above.

2. Pressurizing test sample with test gas to the test pressure, as described above.

3. Within five minutes, using a leak detecting fluid or hydrogen gas detector or other equally sensitive method, verify that the leak rate is in accordance with 5.3.2.3, Acceptance Criteria.

5.3.2.3 Acceptance Criteria

The acceptable leak rate shall be less than 10 normal cm^3/hr., or no bubble formation for each pressure/temperature set tested.

5.3.2.4 Disposition of Components

Parts used for this test may be used for other testing, used for actual service, or returned to stock.

5.3.3 Hydrostatic Burst Test

5.3.3.1 Objective

The object of this test is to demonstrate the ability of a fitting assembly to withstand a minimum of four (4) times the rated pressure without failure.

5.3.3.2 Method of Test

5.3.3.2.1 Pre Test

There are no pretest conditioning activities.

5.3.3.2.2 Test Conditions

Three fitting assemblies shall be used for this test. The test is to be conducted with the fluid as specified in Table 1, Hydraulic Cyclic Endurance Test Requirements by pressurizing

each test sample to four (4) times the rated pressure.

The pressure shall be increased at a rate not to exceed 16 percent of the fittings rated pressure per second.

5.3.3.3 Acceptance Criteria

No rupture, burst, tearing or shearing of metal or catastrophic failure shall occur at four (4) times rated pressure.

5.3.3.4 Disposition of Components

Parts used for this test shall not be used for other tests, used for actual service, or returned to stock.

5.3.4 Hydraulic Cyclic Endurance Test

5.3.4.1 Objective

This test is to demonstrate the ability of a fitting to function as designed after 1 000 000 cycles at 133 percent of the rated pressure.

5.3.4.2 Method of Test

5.3.4.2.1 Pre Test

There are no pretest conditioning activities.

5.3.4.2.2 Test Procedure

Three fitting assemblies shall be used for this test.

The hydraulic endurance test shall be conducted in accordance with the requirements specified in 5.3.4.2.2, and Table 1, Hydraulic Cyclic Endurance Test Requirements.

5.3.4.3 Acceptance Criteria

The test sample shall be examined to demonstrate there is no rupture, burst, tearing or shearing of metal.

After completion of 1 000 000 cycles the test sample shall pass section 5.3.2, External Leak Test.

5.3.4.4 Disposition of Components

Following this test, including the External Leak Test described in section 5.3.2, parts used for this test shall not be used for other tests, used for actual service, or returned to stock.

5.3.5 Gas Cyclic Endurance Test

5.3.5.1 Objective

This test supplements the 5.4, Hydraulic Cyclic Endurance Test, by adding a test that addresses the unique effects of testing with a gas (e.g. hydrogen versus with a hydraulic fluid). It tests only the high end of the pressure range, which has previously been viewed to be the "worst case", and by keeping the pressure ratio to less than 2:1, it eliminates the explosive decompression testing issue caused by extremely rapid gas pressure cycling.

Note: hydraulic cycling does not address explosive decompression.

5.3.5.2 Method of Test

5.3.5.2.1 Pre Test

See section 5.3.4.2.1 Pre Test.

5.3.5.2.2 Test Procedure

Three fitting assemblies shall be tested.

Each fitting assembly shall be tested using hydrogen, for 100 000 cycles of continuous operation. Cycling pressure shall be from 0,7 times rated pressure to 1,33 times rated pressure at a rate not to exceed 20 cycles per minute.

1. Room Temperature Cycling:

The fitting assembly shall be operated through 96 percent of the total cycles.

2. High Temperature Cycling:

The cycling procedure shall be repeated with the part stabilized at the appropriate maximum temperature of 85°C, or the maximum rated temperature for 2 percent of the total cycles.

3. Low Temperature Cycling:

The cycling procedure shall be repeated with the part stabilized at -40°C for 2 percent of the total cycles.

5.3.5.3 Acceptance Criteria

The test sample shall be examined to demonstrate there is no rupture, burst, tearing or shearing of metal.

After completion of 100 000 cycles, the test sample shall pass section 5.3.2, External Leak Test.

5.3.5.4 Disposition of Components

Following testing described in section 5.5, including the External Leak Test described in section 5.3.2, parts used for this test shall not be used for other tests, used for actual service, or returned to stock.

5.3.6 Rotary Flex Test

5.3.6.1 Objective

This test shall determine if a fitting assembly can withstand a specified vibration without leakage or component failure.

Note: The vibration modelled is similar to the vibration mode expected with rotating equipment.

5.3.6.2 Method of Test

5.3.6.2.1 Pre Test

See section 5.3.2.2.1 Pre Test.

5.3.6.2.2 Test Procedure

Three fitting assemblies shall be tested.

A test sample shall conform to that described in ASTM F1387 -2005 Performance of Piping and Tubing Mechanically Attached Fittings, test procedure listed in section A10 Rotary Flex Test except using a bending moment equivalent to 45 percent of actual tubing yield stress of the tubing material in section A10.4.3.

Pressurize each test sample with hydrogen to 10 percent of rated pressure, but not to be less than 34 KPa (5 psi).

Apply a bending load to the end of the tube until the combined axial stress is 45 percent of the actual yield strength of the tubing material.

Submit the test sample to a vibration or reverse bending moment of 30 ± 5 Hz until failure or 1 000 000 cycles, whichever comes first.

5.3.6.3 Acceptance Criteria

The fitting assembly shall be examined to demonstrate there is no rupture, burst, tearing or shearing of metal.

Any leakage or failure of any component prior to completion of 1 000 000 cycles shall be considered a failure.

After completion of 1 000 000 cycles the test sample shall pass section 5.3.2, External Leak Test.

5.3.6.4 Disposition of Components

Following the test described in section 5.6, including the External Leak Test described in section 5.3.2, arts used for this test shall not be used for other tests, used for actual service, or returned to stock.

5.3.7 Explosive Decompression

5.3.7.1 Objective

This test applies to elastomeric and plastic materials used in the fitting assembly. The test simulates the pressure excursions a gasket material may encounter if the fitting was intentionally or unintentionally disconnected during operation, or if a system that used the fitting assembly experienced a rapid pressure excursion.

5.3.7.2 Method of Test

5.3.7.2.1 Pre Test

See section 5.3.2.2.1 Pre Test.

5.3.7.2 Test Procedure

Five fitting assemblies shall be tested.

a. Internally pressurize the fitting assembly with hydrogen gas to 1,33 times the rated pressure.

b. Soak at 85°C for 70 hours at pressure.

c. Rapidly depressurize the test samples within 3 seconds.

Repeat steps a, b, and c, three additional times.

5.3.7.3 Acceptance Criteria

The fitting shall pass the leakage test specified in section 5.3.1, External Leak Test.

At the conclusion of this test, material samples shall remain intact, not swell greater than 25 percent nor shrink more than 1 percent, and the weight loss shall not exceed 10 percent. After examination, by unaided eye, the sealing surfaces of the material shall have no pitting, cracking or blisters.

5.3.7.4 Disposition of Components.

Following the tests described in section 5.7, including the External Leak Test specified in section 5.3.1, parts used for this test shall not be used for other tests, used for actual service, or returned to stock.

5.3.8 Make and Break Test

5.8.1 Objective

This test demonstrates the ability of a reusable connection. This test only applies to fittings designed so that the connection can be disassembled and reassembled multiple times. A union would be an example of this type of fitting.

5.3.8.2 Method of Test

5.3.8.2.1 Pre Test

See section 5.3.2.2.1 Pre Test.

5.3.8.2 Test Procedure

Six fitting assemblies shall be used for this test.

The test samples shall be completely disconnected and reconnected (all connections reassembled) a total of 25 times, each time according to the manufacturers specifications. The reconnected test samples shall then undergo the leak test under 5.3.1, External Leak Test.

5.3.8.3 Acceptance Criteria

The test samples shall be examined to check that no fatigue or component damage is visible.

The test samples must pass the leak test under 5.3.2, External Leak Test, at completion of this test.

5.3.8.4 Disposition of Components

Parts used for this test may be used for other testing.

Parts used for this test may not be used for actual service or returned to stock.

5.3.9 Cold Gas in Warm Fitting Test

5.3.9.1 Objective

This test is applicable to the fittings that are used where pre-cooled gas is carried.

5.3.9.2 Method of Test

5.3.9.2.1 Pre Test

See section 5.3.2.2.1 Pre Test.

5.3.9.2.2 Test Procedure

The fitting shall be subjected to pre-cooled hydrogen gas at −40 °C (+0 °C, −3 °C) at a flow rate of 30 g/s for a minimum of 3 minutes. For those fittings which have ports open to the atmosphere or external moving parts, this test shall be conducted at 90 % relative humidity (ambient conditions). The fitting shall be depressurised and re-pressurised after a 2 minute holding period at room temperature.

This test shall be repeated 10 times. Then the test procedure shall be repeated for additional 10 cycles, except that the hold period shall be increased to 15 minutes.

5.3.9.3 Acceptance Criteria

The acceptable leak rate shall be less than 10 normal cm^3/hr or no bubble formation for each

pressure/temperature set tested.

There shall be no failure at minimum rated temperature and maximum pressure combinations.

There shall be no leakage at maximum pressure at 20°C ± 5°C after minimum temperature test.

The test sample shall be examined to ensure that no fatigue or component damage is visible.

The test sample must pass the leak test under 5.3.2, External Leak Test, at completion of this test.

5.3.9.4 Disposition of Components

Parts used for this test may be used for other testing.

Parts used for this test may not be used for actual service or returned to stock.

Table 1. Hydraulic Cyclic Endurance Test Requirements

Test parameter	Value of parameter and procedure
Test liquid	Hydraulic fluid in accordance with ISO 6743-4, e.g., HM, with a viscosity of ISO VG 32, in accordance with ISO 3448, or water.
Test pressure	Test pressure shall conform to the waveform shown in ISO 6605 with peak pressure of 133 percent of rated pressure, and an impulse frequency of 0,5 Hz to 1,25 Hz.
Test duration	1 000 000 pressure impulse cycles.
Pass/fail criterion	None of the test fitting assemblies shall leak or fail during the test.

6 Marking

6.1 Marking Information

Fittings shall be permanently marked with the following information:

a. Pressure class or rated pressure;

b. Manufacturer's name, trademark, or symbol;

c. Heat code of the material or marking directly traceable to the material test report;

d. Type of material;

e. Designation if the fitting is a metric size instead of an inch size; and

f. Symbol of the testing organization for compliance with this document.

When the size and shape of fittings do not permit all the above markings, they may be omitted in the reverse order given above, provided the information is supplied in the manufacturers' literature.

6.2 Marking Methods

Markings shall be permanent. Fittings may be marked by laser, etching, stamping, molding, permanent label, or by other means.

7 Component Literature

Clear, concise, printed instructions and diagrams, stated in terms understandable and adequate for proper assembly, installation, maintenance and operation, shall be made available by the manufacturer of the fitting.

The information not included on the fitting shall be included with the component literature.

The certifying agency shall have the right to direct additional information be included in the instructions.

Bibliography

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I. Specific Components of Motor Vehicles using Compressed Natural Gas (CNG) in their Propulsion System;

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