International Standard

ISO 19882

Second edition
2025-02

Gaseous hydrogen — Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers

Hydrogène gazeux — Dispositifs limiteurs de pression thermiquement activés pour les conteneurs de carburant de véhicules à hydrogène comprimé

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

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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 19882:2018), which has been technically revised.

The main changes are as follows:

— addition of pilot TPRDs and PRD valve coverage;

— updates to design qualification test procedures;

— additional test requirements for excess torque resistance, hydrostatic strength and waterjet protection.

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 thermally activated pressure relief devices for compressed hydrogen fuel containers. The successful commercialization of hydrogen land vehicle technologies requires standards pertaining 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.

Documents which apply to hydrogen fuel vehicles and hydrogen fuel subsystems include IEC 62282- 4-101, SAE J2578, SAE J2579, UN ECE R134, or UN GTR No. 13.

Annex A presents an informative record of recommended fuel container, fuel storage subsystem and vehicle level requirements. The statements in Annex A are intended as recommendations for consideration of inclusion by the organizations and committees developing standards on these sub-system and vehicle level standards.

Annex B presents a rationale for the design qualification tests in this document.

This document is based on the CSA Standard CSA/ANSI HPRD 1:21.

Gaseous hydrogen — Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers

1 Scope

This document specifies minimum requirements for pressure relief devices intended for use on hydrogen fuelled vehicle fuel containers that comply with ISO 19881, IEC 62282-4-101, CSA/ANSI HGV 2, EC79/EU406, SAE J2579, UN ECE R134, or the UN GTR No. 13.

The applicability of this document is limited to thermally activated pressure relief devices installed on fuel containers containing gaseous hydrogen according to ISO 14687 for fuel cell and internal combustion land vehicles. This document specifies requirements for thermally activated pressure relief devices acceptable for use on-board the following types of land vehicles:

— light-duty vehicles;

— heavy-duty vehicles;

— industrial powered trucks, such as forklifts and other material handling vehicles.

Requirements for other types of land vehicles such as rail, off-road, etc., can be derived with due consideration of appropriate service conditions.

This document does not apply to reseating, resealing, or pressure-activated devices.

Pressure relief devices can be of any design or manufacturing method that meets the requirements of this document.

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 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 6270-2, *Paints and varnishes — Determination of resistance to humidity — Part 2: Condensation (in-cabinet exposure with heated water reservoir)*

ISO 14687, *Hydrogen fuel quality — Product specification*

ISO 19881, *Gaseous hydrogen — Land vehicle fuel containers*

ASTM D572, *Standard Test Method for Rubber — Deterioration by Heat and Oxygen*

ASTM D1149, *Standard Test Methods for Rubber Deterioration — Cracking in an Ozone Controlled Environment*

ASTM D1193, *Standard Specification for Reagent Water*

CSA/ANSI HGV 2, *Compressed hydrogen gas vehicle fuel containers*

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

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

SAE J2719, *Hydrogen Fuel Quality for Fuel Cell Vehicles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
flow capacity
<pressure relief device> capacity in volume per unit time at specified conditions

3.2
fusible material
metal, alloy, or other material capable of being melted by heat where the melting is integral to the function of the *pressure relief device* (3.7)

3.3
manufacturer's specified activation temperature
temperature, as specified by the pressure relief device manufacturer, at which the *pressure relief device* (3.7) is designed to release pressure

3.4
manufacturer's specified nominal working pressure
highest settled pressure at a uniform gas temperature of 15 °C of the container or container assembly with which the *pressure relief device* (3.7) may be used, as specified by the pressure relief device manufacturer

3.5
normal cubic centimetre
Ncm^3
dry gas that occupies a volume of 1 cm^3 at a temperature of 293,15 K (20 °C) and an absolute pressure of 101,325 kPa

3.6
pilot-activating device
valve or device designed to be used as a trigger for pilot-activated *pressure relief device* (3.7) valves, other than pilot TPRDs

3.7
pressure relief device
PRD
device that, when activated under specified performance conditions, is used to vent the container contents

Note 1 to entry: Reseating and resealing devices are not addressed by this document.

3.8
thermally activated pressure relief device
TPRD
pressure relief device (3.7) activated by temperature

3.8.1
direct-acting TPRD
TPRD (3.8) having a heat-reactive element that acts directly with the gas control portion of the *PRD* (3.7)

3.8.2
long-trigger TPRD
TPRD (3.8) having a heat-reactive element that is more than 10 times longer than the longest dimension of the *PRD* (3.7) body

3.8.3
pilot TPRD
TPRD (3.8) designed to be used as the trigger for the *pilot-activated PRD valve* (3.9.2)

3.8.4
remote-sensing TPRD
TPRD (3.8) having one or more remote heat-reactive element(s) such that it can be heated separately from, and acts indirectly with, the gas control portion of the PRD

3.9
pressure relief device valve
PRD valve
single-use valve that is intended to be opened to empty a hydrogen container

3.9.1
negative-acting pilot-activated PRD valve
PRD (3.7) that is designed to be triggered by a remote heat-sensing element or device and that will react to a decrease in pressure being applied to the *pilot-activated PRD valve* (3.9.2) activation port

3.9.2
pilot-activated PRD valve
single-use valve that is intended to be opened to empty a hydrogen container by the action of an attached *PRD* (3.7)

3.9.3
positive-acting pilot-activated PRD valve
PRD (3.7) that is designed to be triggered by a remote heat-sensing element or device and that will react to a positive pressure applied to the *pilot-activated PRD valve* (3.9.2) activation port

4 Service conditions

4.1 General

Fuel containers can accidentally be exposed to fire or elevated temperature. These conditions can act to increase the contained-pressure or to degrade the structural materials, depending on the container type and materials of construction. A pressure relief device provides a means to vent the fuel container under these conditions.

A pressure relief device may not be suitable for all container types, sizes or installations. Fuel container or installation standards may require that a pressure relief device be tested in conjunction with other components.

The service conditions in 4.2 through 4.5 are representative of what can be seen in an automotive service. These service conditions are provided as a basis for the design, manufacture, inspection and testing of pressure relief devices used in compressed hydrogen vehicle fuel containers.

4.2 Design service life

The design service life of the pressure relief device shall be specified by the manufacturer.

NOTE The testing described in this document is based on an expected service life of 20 years. Service life values can be extended by adjusting the filling or duty cycles, as applicable, by the appropriate factor (ratio). For example, a service life of 25 years will require cycling to be multiplied by 1,25.

4.3 Nominal working pressure

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

a) “H35” — 35 MPa;

b) “H70” — 70 MPa.

Other nominal working pressures for hydrogen gas besides those defined are allowed if the required qualification test requirements of this document are met.

4.4 Durability test cycles

Pressure relief devices shall be designed to withstand 15 000 pressure cycles per the cycling requirements in 7.2. Pressure cycling includes 10 cycles between ≤ 2 MPa and ≥ 150 % of the manufacturer’s specified nominal working pressure.

NOTE The maximum pressure under the condition of fuelling station dispenser fault management is 150 % of the vehicle nominal working pressure, as defined in ISO 19880-1, SAE J2760, SAE J2579-2023, Appendix A and CSA/ANSI HGV 4.1.

4.5 Temperature range

The pressure relief device shall be designed to maintain pressure integrity from −40 °C to 85 °C.

It is possible that operational gas temperatures are outside of this range. The manufacturer may choose to test beyond these temperatures.

5 Quality assurance

Quality system programs shall be established and operated to demonstrate that pressure relief devices are produced in accordance with the qualified design.

6 General requirements

6.1 Material requirements

6.1.1 General

Pressure-containing materials in contact with hydrogen shall be determined to be acceptable in hydrogen service, with particular attention to hydrogen embrittlement and hydrogen-accelerated fatigue. Materials and design shall be such that there will be no significant change in the functioning of the device, deformation or mechanical change in the device, and no harmful corrosion, deformation, or deterioration of the materials.

6.1.2 Metallic materials

Material acceptability for metallic materials shall be demonstrated by testing or by referencing published data for the same material, representative form (e.g. bar or plate, forging or casting), similar strength and equivalent service conditions.

NOTE 1 Information regarding material performance in hydrogen environments can be found in ISO/TR 15916, ANSI/CSA CHMC 1, ASME B31.12 and SAE J2579:2023 Appendix B. Hydrogen compatibility can also be demonstrated by testing in hydrogen environments as anticipated in service, such as the pressure cycling test specified in 7.2.

NOTE 2 Some fusible alloys can contain heavy metals that can be considered environmentally unacceptable by some customers and can be prohibited by some jurisdictions.

Resistance to chloride stress corrosion cracking shall be taken under consideration if selecting stainless steel materials. Resistance to corrosion cracking shall be taken under consideration if selecting carbon steel materials (e.g. by choosing appropriate coating, manufacturing processes).

Resistance to stress corrosion cracking and sustained load cracking shall be taken under consideration if selecting aluminium materials.

Resistance to galvanic corrosion shall be taken under consideration when joining components containing dissimilar materials.

6.1.3 Non-metallic materials

The suitability of non-metallic organic materials (e.g. rubbers, plastics) for hydrogen service shall be verified, taking into consideration the fact that hydrogen diffuses through these materials more easily than through metals.

Non-metallic materials shall retain their mechanical stability with respect to strength (e.g. fatigue properties, endurance limit, creep strength, elasticity) when exposed to the full range of service conditions and lifetime as specified by the manufacturer.

Materials shall be sufficiently resistant to the chemical and physical action of the fluids that they contain and to environmental degradation. The chemical and physical properties necessary for operational safety should not be significantly affected within the scheduled lifetime of the component. Specifically, when selecting materials and manufacturing methods, due account should be taken of the material's wear resistance, impact strength, aging resistance, the effects of temperature variations, effects that arise when materials are put together, the effects of ultraviolet radiation, rapid gas decompression and the degradation effects of hydrogen on the mechanical performance of a material.

The manufacturer shall verify the material's suitability, including consideration for such characteristics as permeability, creep, long-term aging, stress cracking, and retention of mechanical properties, as appropriate. Safety margin shall be demonstrated by the hydrostatic strength test, allowable leakage, and the use of materials below their creep threshold for their qualification temperature.

NOTE Guidance to account for the degradation effects of hydrogen on the mechanical performance of a material can be found in ISO/TR 15916 and ANSI/AIAA G-095. Hydrogen compatibility for non-metallic materials can also be demonstrated by testing in hydrogen environments as anticipated in service by one or more of the following:

a) documented field experience with successful performance of the material in hydrogen environments with similar service conditions;

b) performance of industry approved standards for hydrogen compatibility, such as CSA/ANSI CHMC 2;

c) use of hydrogen as the test gas for the pressure cycling test specified in 7.2.

6.2 Design requirements

The design shall be such that, once activated, the pressure relief device fully vents the contents of the fuel container. The design should minimize the possibility of external hazards (e.g. projectiles) resulting from the activation of the device. Any material released shall not interfere with the proper venting of the PRD.

The PRD shall be designed to address degradation from creep or plastic deformation. The design or manufacturing process should account for the effects of material defects, particularly casting and shrinkage voids, that adversely impact the robustness of the design.

6.3 Flow capacity

The flow capacity shall be determined by the flow capacity test in 7.12.

The adequacy of the flow capacity of pressure relief devices for a given application shall be demonstrated by bonfire testing in accordance with ISO 19881, CSA/ANSI HGV 2, SAE J2579, or the UN GTR No. 13 for fuel cell vehicles and by the minimization of the hazardous effects of the pressure peaking phenomenon which can take place during high flow rate releases from small diameter vents in enclosed spaces.

6.4 Failure modes and effects analysis (FMEA)

Design FMEA and process FMEA, or equivalent shall be performed for pressure relief devices.

NOTE FMEA is a methodology used in the automotive industry to identify potentially hazardous failure modes of safety devices and recommend changes in design, manufacturing, inspection or testing which 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.

7 Design qualification testing

7.1 Test requirements

7.1.1 General

Design qualification testing shall be conducted on finished pressure relief devices that are representative of the normal production. Test reports shall be kept on file by the manufacturer and should be made available for review by fuel container manufacturers and end users upon request.

The design qualification testing required by this document shall, as appropriate and necessary, be supplemented by additional tests defined in “design controls” or “recommended action” in the design FMEA.

PRDs representative of each design and design change shall be subjected to tests as prescribed in Table 1. Designs sufficiently similar to an existing fully qualified design shall be permitted to be qualified through a reduced test program as defined in Table 1. Design changes not falling within the guidelines in Table 1 shall be qualified as original designs.

Any additional tests or requirements shall be performed in accordance with appropriate published standards or procedures, as available.

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

Caution shall be taken to confirm that the specified test temperature and test pressure are maintained. Unless stated otherwise, the tests specified herein shall be conducted with the following tolerances on specified temperatures and pressures:

a) −40 °C (+0, −5) °C;

b) +85 °C (+5, −0) °C;

c) P_{max} (+2, -0) MPa;

d) P_{min} (+0, -1) MPa.

Pilot-activated PRD valves shall be tested as TPRDs, except as noted in individual tests.

Table 1 — Test requirements for design and design changes

ISO 19882 Tests	Original design	Manufacturer's specified nominal working pressure	Manufacturer's specified activation temperature	Elastomeric seals	Orifice size	Body material	Surface coating	Inlet connection	Outlet connection
7.2 Pressure cycling	X	X	X	X	X*	X		X	
7.3 Accelerated life	X	X	X	X		X			
7.4 Thermal cycling	X		X	X		X	X		
7.5 Accelerated cyclic corrosion	X			X		X	X		
7.6 Automotive fluids exposure	X	X				X	X		
7.7 Atmospheric exposure	X			External only					
7.8 Stress corrosion cracking resistance	X	X				X	X	X	
7.9 Impact due to drop and vibration	X	X	X			X		X	
7.10 Leakage	X	X	X	X		X	X	X	X
7.11 Bench top activation	X	X	X	X	X	X	X		
7.12 Flow capacity	X	X			X			X	X
7.13 High pressure activation and flow	X	X			X			X	X
7.14 Excess torque resistance	X					X		X	X
7.15 Hydrostatic strength	X				X*	X		X	X
7.16 Water jet protection	X								X

NOTE "X" requires physical testing.

"X*" applies only if the orifice is on the high-pressure side.

7.1.2 Test gases

7.1.2.1 General

Unless otherwise specified, all tests shall be conducted using hydrogen or a non-reactive gas.

The dew point of the test gas at the test pressure shall be at a temperature at which there is no icing, or hydrate or liquid formation.

If testing with hydrogen, the component should be purged with a non-reactive gas before and after testing.

Testing described in these requirements can result in the sudden release of test gas at high pressure with dangerous explosive force. Adequate protection from explosion, concussion, and flying debris should be utilized to protect test personnel and facilities.

7.1.2.2 Leak test gas

The leak test gas shall be hydrogen, helium, or a non-reactive gas mixture containing a detectable amount of hydrogen or helium gas.

7.1.2.3 Hydrogen gas

Hydrogen gas used for testing shall be compliant with ISO 14687 or SAE J2719, or meet the following specifications:

a) hydrogen fuel index: ≥ 99,97 %;

b) total non-hydrogen gases: ≤ 300 µmol/mol;

c) water: ≤ 5 µmol/mol; and

d) particle concentrations: ≤ 1 mg/kg.

7.2 Pressure cycling

7.2.1 Sampling

Five finished TPRDs shall be subjected to the pressure cycling test.

When testing pilot-activated PRD valves, the pressure shall be applied to the inlet of the valve that is intended to be connected to the container contents in normal operation. The pilot pressure shall be allowed to achieve whatever pressure cycles develop throughout the test when installed in accordance with the manufacturer's normal installation instructions. No further cycle testing of that portion is required.

A pilot-TPRD shall be tested following TPRD testing requirements.

7.2.2 Procedure

Pressure cycling shall be performed in accordance with the following procedure:

At a sample temperature ≥ 85 °C, the first 10 pressure cycles shall be from ≤ 2 MPa to ≥ 150 % of the manufacturer's specified nominal working pressure rating, followed by 2 240 pressure cycles from ≤ 2 MPa to ≥ 125 percent of the manufacturer's specified nominal working pressure, followed by 10 000 pressure cycles at ambient temperature from ≤ 2 MPa to ≥ 125 % of the manufacturer's specified nominal working pressure, followed by a final 2 750 pressure cycles at a sample temperature ≤ −40 °C from ≤ 2 MPa to ≥ 80 % of the manufacturer's specified nominal working pressure. The pressure cycling shall be performed at a rate not exceeding 10 cycles per minute.

Table 2 — Pressure cycling conditions

Pressure cycles to %	No. of cycles	Sample temperature for cycles
2 MPa to 150 %	First 10	85 °C
2 MPa to 125 %	Next 2 240	85 °C
2 MPa to 125 %	Next 10 000	20 °C
2 MPa to 80 %	Final 2 750	−40 °C
NOTE All cycles are conducted at a rate not greater than 10 cycles per minute.		

7.2.3 Acceptable results

Following the pressure cycling test, the TPRDs (or pilot-activated PRD valves) shall meet the requirements of 7.10, 7.11, and 7.12.

7.3 Accelerated life

7.3.1 Sampling

Accelerated life testing shall be performed on new applicable TPRDs or designs in which the thermal activation mechanism or materials are modified. The test is intended to test for long-term degradation or change of TPRD elements, such as creep of melt materials. For long-trigger or remote-sensing TPRDs, a length or configuration that tests for long-term effects but avoids short-term non-representative failures may be used.

a) Five finished TPRDs shall be subjected to the accelerated life test.

b) Three additional TPRDs shall be subjected to the manufacturer's specified activation temperature until activation.

7.3.2 Procedure

Accelerated life testing shall be performed in accordance with the following procedure:

TPRDs shall be placed in an oven or liquid bath with the temperature of the samples held constant within ±1 °C throughout the test. Pressure on the inlet of the TPRD samples shall be elevated to 125 % of the manufacturer's specified nominal working pressure and held constant within ±0,7 MPa. The pressure supply may be located outside the controlled temperature oven or bath. The volume of liquid or gas should be limited to prevent damage to the test apparatus upon activation and venting. Each sample may be pressurized individually or through a manifold system.

The accelerated life test temperature, T_L (°C), shall be as given by Formula (1):

$$T_L = \left(\frac{0{,}502}{\beta + T_f} + \frac{0{,}498}{\beta + T_{ME}} \right)^{-1} - \beta \qquad (1)$$

where

β is 273,15;

T_f is the manufacturer's specified activation temperature (°C);

T_{ME} is 85 °C.

7.3.3 Acceptable results

a) The five TPRDs tested at their accelerated life test temperature shall not activate in less than 500 h and shall meet the leakage requirements of 7.10.

b) The three TPRDs tested at the manufacturer's specified activation temperature shall activate in less than 10 h.

7.4 Thermal cycling

7.4.1 Sampling

One finished TPRD shall be subjected to the thermal cycling test.

7.4.2 Procedure

Thermal cycling shall be performed in accordance with the following procedure.

The TPRD sample shall be thermally cycled between −40 °C and 85 °C as follows.

a) Place an unpressurized TPRD in a liquid bath maintained at −40 °C for a period of 2 h or more. Transfer to a liquid bath maintained at 85 °C within 5 min.

b) Maintain the unpressurized TPRD in a liquid bath maintained at 85 °C for a period of 2 h or more. Transfer to a liquid bath maintained at −40 °C within 5 min.

c) Repeat steps a) and b) until a total of 15 thermal cycles have been achieved.

d) With the TPRD conditioned for a minimum of 2 h in the −40 °C liquid bath, cycle the TPRD between ≤ 10 % of the manufacturer's specified nominal working pressure and ≥ 80 % of the manufacturer's specified nominal working pressure for a total of 100 cycles. The pressure cycling shall be performed at a rate not exceeding 10 cycles per minute. The liquid bath shall be maintained at −40 °C during this test.

When testing pilot-activated PRD valves, apply the pressure to the inlet of the valve that is intended to be connected to the container contents in normal operation. Allow the pilot pressure to achieve whatever pressure cycles develop throughout the test when installed in accordance with the manufacturer’s normal installation instructions. No further cycle testing of that portion is required. When testing long trigger devices, the longest length permitted by the design shall be used for this test.

7.4.3 Acceptable results

Following the thermal and pressure cycling, the TPRD shall meet the requirements of 7.10 (except that the test shall be conducted at ≤ −40 °C), 7.11, and 7.12.

7.5 Accelerated cyclic corrosion

7.5.1 Sampling

Three finished TPRDs shall be subjected to the accelerated cyclic corrosion test.

7.5.2 Procedure

Accelerated cyclic corrosion shall be performed in accordance with the following procedure:

The TPRD samples shall be exposed to an accelerated laboratory corrosion test, under a combination of cyclic conditions (salt solution, various temperatures, humidity, and ambient environment). The test method is comprised of 1 % (approximate) complex salt mist applications coupled with high temperature, high humidity and high temperature dry off. One (1) test cycle is equal to 24 h, as illustrated in Figure 1.

The apparatus used for this test shall consist of a fog/environmental chamber, suitable water supply conforming to ASTM D1193 Type IV, provisions for heating the chamber and the necessary means of controlling the temperature between 22 °C and 62 °C. The apparatus shall include provisions for a supply of suitably conditioned compressed air and one or more nozzles for fog generation. The nozzle or nozzles used for the generation of the fog shall be directed or baffled to minimize any direct impingement on the test samples.

The apparatus shall consist of the chamber design defined in ISO 6270-2. During "wet-bottom" generated humidity cycles, confirm that visible water droplets are found on the samples to verify proper wetness.

Steam generated humidity may be used provided the source of water used in generating the steam is free of corrosion inhibitors. During steam generated humidity cycles, confirm that visible water droplets are found on the samples to verify proper wetness.

The apparatus for the dry off stage shall have the ability to obtain and maintain the following environmental conditions: temperature: 60 °C ± 2 °C and humidity: ≤ 30 % RH. The apparatus shall also have sufficient air circulation to prevent temperature stratification and also allow thorough drying of the test samples.

The force/impingement from this salt application should not remove corrosion or damage the coatings/paints system of test samples.

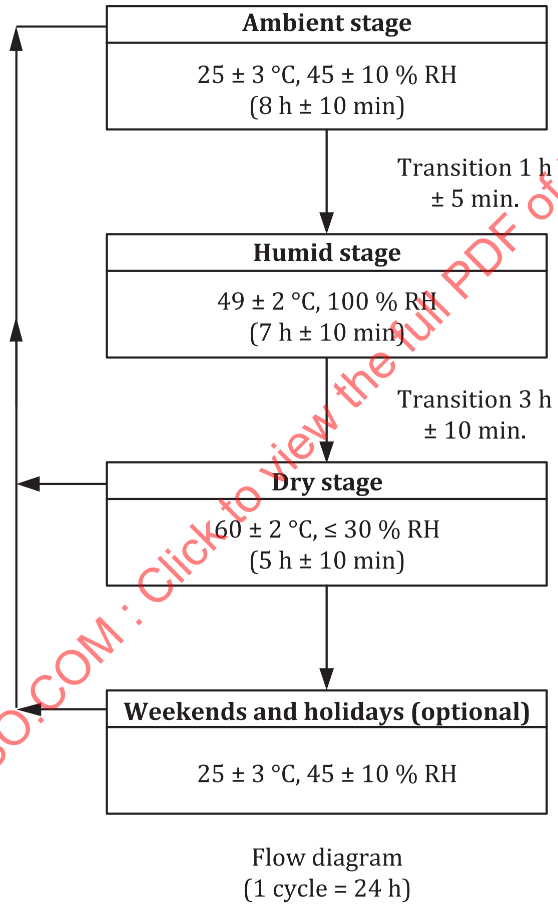

Figure 1 — Accelerated cyclic corrosion flow diagram

The complex salt solution in percent by mass shall be as specified below:

a) sodium chloride (NaCl): 0,9 % (e.g. 9 g/kg);

b) calcium chloride ($CaCl_2$): 0,1 % (e.g. 1 g/kg);

c) sodium bicarbonate ($NaHCO_3$): 0,075 % (e.g. 0,75 g/kg).

Sodium chloride shall be reagent grade or food grade. Calcium chloride shall be reagent grade. Sodium bicarbonate shall be reagent grade (e.g. baking soda or comparable product is acceptable). Water shall meet ASTM D1193 Type IV requirements.

Either $CaCl_2$ or $NaHCO_3$ material shall be dissolved separately in water and added to the solution of the other materials. If all solid materials are added dry, an insoluble precipitate can result.

The TPRDs shall be installed in accordance with the manufacturer's recommended procedure and exposed to the cyclic corrosion test method illustrated in the flow diagram (Figure 1). Repeat the cycle daily until 100 cycles of exposure have been completed. For each salt mist application, the solution shall be sprayed as an atomized mist, using the spray apparatus to mist the components until all areas are thoroughly wet/dripping. Suitable application techniques include using a plastic bottle, or a siphon spray powered by oil-free regulated air to spray the test samples. The quantity of spray applied should be sufficient to visibly rinse away salt accumulation left from previous sprays. The first salt mist application occurs at the beginning of the ambient stage. Each subsequent salt mist application should be applied approximately 90 min after the previous application in order to allow adequate time for the test sample to dry.

Humidity ramp times between the ambient and wet conditions, and between the wet and dry conditions, can have a significant effect on test acceleration (this is because corrosion rates are highest during these transition periods). The time from ambient to wet conditions shall be 60 min ± 5 min and the transition time between wet and dry conditions shall be 180 min ± 10 min.

7.5.3 Acceptable results

Immediately following the cyclic corrosion test, the TPRDs shall be rinsed with fresh tap water and allowed to dry. The tested samples shall then meet the requirements of 7.10, 7.11 and 7.12.

7.6 Automotive fluids exposure

7.6.1 Sampling

External portions of TPRDs shall be able to withstand exposure to the following fluids without mechanical degradation. Resistance may be determined by the following test, by comparable published data, or by known properties (e.g. 300 series stainless steel).

One finished TPRD shall be subjected to the automotive fluids exposure test.

7.6.2 Procedure

The external surfaces of the TPRD sample shall be exposed to the following test. The inlet and outlet connections of the test sample shall be connected or capped in accordance with the manufacturer's installation instructions. The test sample shall be exposed at an ambient temperature by spraying the exterior of the component once per hour, 24 times, over a period of up to three days (three 8 h shifts over 3 days or 24 h straight, for example). Alternatively, the TPRD sample may be immersed in the solution for a period of 24 h. In the immersion method, the fluid shall be replenished as needed to assure complete exposure for the duration of the test. A distinct test shall be performed with each of the following three fluids. One TPRD sample may be used for all three exposures sequentially.

a) Sulfuric acid – 19 % solution by volume in water (e.g. 190 ml/l solution).

b) Ethanol/gasoline – 10 %/90 % concentration of E10 fuel (e.g. 100 ml/l ethanol / 900 ml/l gasoline).

c) Windshield washer fluid – 50 % by volume solution of methyl alcohol and water (e.g. 500 ml/l solution).

7.6.3 Acceptable results

After exposure to each chemical solution, the TPRD sample shall be wiped off and rinsed with water and examined. The TPRD shall not show signs of mechanical degradation that can impair the function, such as cracking, softening or swelling. Cosmetic changes such as pitting or staining are not considered failures.

At the conclusion of all exposures, the TPRD sample(s) shall meet the requirements of 7.10, 7.11, and 7.12

7.7 Atmospheric exposure

7.7.1 General

The atmospheric exposure test applies to the qualification of PRDs that have non-metallic materials exposed to the atmosphere during normal operating conditions.

7.7.2 Oxygen aging

7.7.2.1 Sampling

Three samples of each non-metallic material that provides a fuel containing seal shall be subjected to the oxygen aging test.

7.7.2.2 Procedure

The oxygen aging test shall be performed in accordance with the following procedure:

The samples shall be exposed to oxygen for 96 h at 70 °C at 2 MPa in accordance with ISO 188 or ASTM D572.

7.7.2.3 Acceptable results

The samples shall not crack or show visible evidence of deterioration after exposure to oxygen aging.

7.7.3 Ozone

7.7.3.1 Sampling

Three samples of each non-metallic material shall be subjected to the ozone test.

7.7.3.2 Procedure

The ozone test shall be performed in accordance with one of the following procedures:

a) specification of elastomer compounds with established resistance to ozone;

b) pressure relief device testing in accordance with ISO 1431-1 or ASTM D1149;

c) the test piece which shall be stressed to 20 % elongation shall be exposed to air at 40 °C with an ozone concentration of 50 parts per hundred million for 120 h.

7.7.3.3 Acceptable results

The samples shall not crack or show visible evidence of deterioration after exposure to ozone.

7.8 Stress corrosion cracking resistance

7.8.1 Sampling

For TPRDs containing components made of a copper-based alloy exposed to the outside environment, one TPRD sample shall be tested as an assembly, such that the copper alloy components are subjected to the stresses normally imposed on them as a result of assembly. This test is not applicable to internal components that are only exposed to hydrogen during service.

7.8.2 Procedure

The TPRD sample shall be degreased and then continuously exposed for ten days to a moist ammonia-air mixture maintained in a glass chamber having a glass cover. Aqueous ammonia having a specific gravity of

0,94 shall be maintained at the bottom of the glass chamber below the samples at a concentration of 20 ml/l of chamber volume. The sample shall be positioned 35 mm ± 5 mm above the aqueous ammonia solution and supported in an inert tray. The moist ammonia-air mixture shall be maintained at the atmospheric pressure with the temperature constant at 35 °C ± 5 °C.

7.8.3 Acceptable results

Copper alloy components shall not exhibit cracking or delamination due to this test.

7.9 Impact due to drop and vibration

7.9.1 Impact due to drop

7.9.1.1 Sampling

TPRD samples shall be representative of their final assembled form. Up to six separate test samples may be used such that all six of the major axes are covered (i.e. one direction drop per sample, covering the opposing directions of 3 orthogonal axes: vertical, lateral and longitudinal). At the manufacturer’s discretion, one TPRD sample may be dropped in all six orientations.

7.9.1.2 Procedure

The TPRD sample shall be dropped from a height of ≥ 2 m without restricting its motion as a result of gravity, at ambient temperature onto a smooth concrete surface. The TPRD is allowed to bounce on the concrete surface after the initial impact.

7.9.1.3 Acceptable results

After each drop, the test sample shall be examined for visible damage. Any of the six dropped orientations that do not have exterior damage that indicates that the part is unsuitable for use (i.e. threads damaged sufficiently that part is rendered unusable), shall then meet the requirements of 7.9.2.

Any test samples with damage from the drop that results in the TPRD not being able to be installed (e.g. thread damage) shall not proceed to 7.9.2 and shall not be considered a failure of this test.

7.9.2 Vibration

7.9.2.1 Sampling

Each of the TPRD samples dropped in 7.9.1 and one additional TPRD sample not subjected to a drop shall be subjected to the vibration test.

7.9.2.2 Procedure

The vibration test shall be performed in accordance with the following procedure:

The TPRD samples shall be mounted in accordance with the manufacturer's installation instructions and vibrated for 30 min along each of the three orthogonal axes (vertical, lateral and longitudinal) at the most severe resonant frequencies. TPRDs with long triggering elements shall be mounted and tested with a length that tests all relevant mounting conditions covered by the manufacturer's installation instructions. More than one sample may be used if needed. This shall include at least one end and intermediate mounting, if mounts at intervals are used.

The frequencies shall be determined by the following: acceleration of 1,5 g with a sweep time of 10 min, within a sinusoidal frequency range of 10 Hz to 500 Hz. If the resonance frequency is not found in this range, the test shall be conducted at 40 Hz.

7.9.2.3 Acceptable results

Following this test, each TPRD sample shall not show any indication of fatigue or component damage, and shall meet the requirements of 7.10, 7.11 and 7.12.

7.10 Leakage

7.10.1 Sampling

Samples shall include one new TPRD that has not been subjected to design qualification testing and additional TPRD samples as specified in other tests in Clause 7.

7.10.2 Procedure

The leakage test shall be performed in accordance with the following procedure.

— The TPRD sample shall be thermally conditioned at each of the required test temperatures and held pressurized to ≥2 MPa for at least one hour to ensure thermal stability before testing. At all test temperatures, immerse the sample in a suitable test medium for 1 min, or use a global accumulation method (or equivalent). The TPRD is pressurized with leak test gas at the inlet.

— The TPRD shall be conditioned at room temperature (20 °C ± 5 °C) until thermal stability is attained, and pressurized at 125 % of the nominal working pressure, and then at 5 % of the nominal working pressure or 2 MPa, whichever is less.

— The TPRD shall be conditioned at −40 °C or lower until thermal stability is attained, and pressurized at both 100 % of the nominal working pressure, and then at 5 % of the nominal working pressure or 2 MPa, whichever is less.

— The TPRD shall be conditioned at 85 °C or higher until thermal stability is attained, and pressurized at 125 % of the nominal working pressure, and then at 5 % of the nominal working pressure or 2 MPa, whichever is less.

7.10.3 Acceptable results

The leak rate shall not exceed 10 Ncm^3/h of hydrogen gas.

If no bubbles are observed for 1 min, the TPRD sample passes the test. If bubbles are detected, the leak rate shall be measured by an appropriate method (e.g. gas chromatography). Leak rates using leak test gas other than hydrogen (e.g. helium) shall be converted to equivalent hydrogen leak rates (see 6.1.1.2 of ECE/TRANS/180/Add.13/Amend.1).

7.11 Bench top activation

7.11.1 Direct-acting TPRD

7.11.1.1 Sampling

Three new TPRD samples are tested without being subjected to other design qualification tests in order to establish a baseline time for activation, which is defined as the averaged activation time of these three units.

Five additional TPRD samples that have been subjected to the testing in 7.2, 7.4, 7.5, 7.6, and 7.9 shall also be subjected to the bench top activation test.

NOTE The bench top activation test does not predict the performance of any TPRDs in the system level bonfire test, as the performance of a given device in the bonfire test is dependent upon the system integration of the TPRD, container valve and fuel storage container.

7.11.1.2 Procedure

The bench top activation test shall be performed in accordance with the following procedure:

The test setup shall consist of a chimney, capable of controlling the air temperature and flow, to achieve a consistent temperature of 600 °C ± 10 °C in the air surrounding the TPRD. The TPRD sample shall not be exposed directly to flame. The TPRD shall be mounted according to the manufacturer's installation instructions. The testing conditions for the new and aged TPRD comparison samples should be the same.

Place a thermocouple in the chimney to monitor the temperature. The temperature shall remain within the acceptable range for 2 min prior to running the test. Prior to insertion, the TPRD sample shall be pressurized to 2,0 MPa ± 0,5 MPa. Insert the TPRD and/or a portion of the triggering element into the chimney and record the time for the TPRD to activate to establish the baseline time for comparison.

If the entire TPRD is not being placed in the chimney, the size of the chimney or heat exposure shall be determined by the manufacturer and be documented.

The TPRDs that were subjected to the tests of 7.2, 7.4, 7.5, 7.6 and 7.9 shall be tested under the same bench top activation conditions.

7.11.1.3 Acceptable results

The maximum difference in the activation time of the three new TPRD samples shall be no more than two minutes.

TPRD samples previously subjected to the design qualification tests of 7.2, 7.4, 7.5, 7.6, and 7.9 shall activate within a period no more than two minutes longer than the baseline activation time.

7.11.2 Pilot-activated PRDs

7.11.2.1 Pilot-activated PRD valves, activation, and flow testing

7.11.2.2 General

The purpose of this test is to demonstrate that the pilot-activated PRD valve will open when activated by the PRD.

7.11.2.3 Test setup

The pilot-activated PRD valve shall be mounted as per the manufacturer's component literature and connected to a pressure reservoir of known volume capable of providing a flow rate representative of the in-use condition, as described in the manufacturer's component literature. This does not need to be as large as in-service containers but shall be large enough to ensure full valve activation when using minimum tank volume as defined by the manufacturer.

A pilot-activating device shall be connected to the pilot-activated valve according to the worst-case conditions defined by the manufacturer. This shall consider the maximum number of PRDs and minimum number of pilot-activated valves and the reverse condition. Particular attention should be paid to the relative flow rates into and out of the pilot system, or any other potential configuration considerations that can affect the ability of the pilot system to activate the pilot-activated valve(s).

The pressure of the pressure reservoir shall be monitored in a manner that the pressure reading is not affected by flow effects at the sensor, and at 1 Hz or faster.

The pressure in the pilot system will be recorded for use in the hydrostatic strength test (see 7.15).

A flow meter may be installed to measure the flow rate through the sample. If used, it shall not reduce the flow rate through the sample. If no flow meter is used, the pressure decay may be used to estimate the flow rate.

7.11.2.4 Test procedure, high pressure

Pressurize the test sample to 100 % of the manufacturer's specified nominal working pressure. Activate the controlling pilot-activating device with heat or in any manner that gives a representative opening action.

This test shall be conducted on at least one sample that has not been subjected to previous testing, one sample subjected to pressure cycling (see 7.2), and one sample subjected to thermal cycling (see 7.4) under the same test conditions.

7.11.2.5 Test procedure, low pressure

Pressurize the test sample to 2,0 MPa ± 0,5 MPa. Activate the controlling pilot-activating device with heat or in any manner that gives a representative opening action.

This test shall be conducted on at least one sample that has not been subjected to previous testing and one sample from each of the following, 7.2, 7.4, 7.5, 7.6, and 7.9, under the same test conditions.

7.11.2.6 Flow rate

The pressure decay curve and flow measurement or calculation shall be recorded and shall be made available to end users. If a gas other than hydrogen is used for testing, the flow rate shall be converted to that expected with hydrogen, and both the original and converted flow rates shall made available.

7.11.2.7 Acceptable results

The pilot-activated PRD valves shall open within the manufacturer's stated activation time from the time of PRD activation, or less than 10 s if no time is stated.

The pilot-activated PRD valves shall open fully within the published pressure range for the device, as determined either by flow rate measurement or by inspection of the position of the internal components.

7.12 Flow capacity

7.12.1 Sampling

Eight TPRD shall be tested for flow capacity. The test sample population shall consist of three new TPRDs, and one TPRD sample from those previously tested in each of 7.2, 7.4, 7.5, 7.6 and 7.9.

7.12.2 Procedure

The flow capacity test shall be performed in accordance with the following procedure.

— Each TPRD shall be activated using the test procedure in 7.11.

— After activation and without cleaning, removing parts or reconditioning, each TPRD sample shall be subjected to the flow test using hydrogen, air or an inert gas wherein the rate of gas released by the device is measured.

— Flow testing shall be conducted with a gas inlet pressure of 2,0 MPa ± 0,5 MPa. The outlet shall be under ambient pressure. The inlet temperature, pressure and flow rate shall be recorded.

— The flow shall be measured with an accuracy within ±2 %.

7.12.3 Acceptable results

The lowest measured value of the eight TPRDs shall not be less than 90 % of the highest flow value.

Flow capacity shall be reported as the lowest measured value of the eight TPRDs.

7.13 High pressure activation and flow

7.13.1 Sampling

Three finished TPRDs shall be subjected to the high-pressure activation and flow test.

Since minimum gas volume in the setup of the test depends in part on the final results, more samples may be required to determine the correct initial setup.

7.13.2 Procedure

The high-pressure activation and flow test shall be performed in accordance with the following procedure.

The test setup shall consist of a chimney, capable of controlling the air temperature and flow, to achieve a consistent temperature of 600 °C ± 10 °C in the air surrounding the TPRD. The TPRD sample shall not be exposed directly to flame. The TPRD shall be mounted according to the manufacturer's installation instructions. A volume of gas shall be installed ahead of the TPRD, in accordance with the manufacturer's installation instructions. The volume of gas shall be sufficient that the TPRD vents down to 10 % of the start pressure in greater than 10 s, and shall be enough that the TPRD reaches a stable Kv before reaching 25 % of the starting pressure.

Pressurize the TPRD sample to the manufacturer's specified nominal working pressure ±2 %. In the case of multiple rated nominal working pressures of a single design, the highest may be used as acceptable test conditions for all pressures. The gas temperature shall be below 40 °C. The pressure of the stored gas shall be measured in such a way that it is not affected by the flow past the pressure measurement device.

Place a thermocouple in the chimney to monitor the temperature. The temperature shall remain within the acceptable range for 2 min prior to running the test. Insert the TPRD into the chimney.

Record the pressure over time, from the point of insertion into the chimney, until venting is complete.

7.13.3 Acceptable results

The flow of the TPRD shall not stop until the tank is below 1 MPa.

7.14 Excess torque resistance

7.14.1 Sampling

One finished TPRD shall be subjected to the excess torque resistance test. A TPRD designed to be connected directly to threaded fittings shall be capable of withstanding, without deformation, breakage, or leakage, a torque of 150 % of the maximum rated torque exerted to install the TPRD.

7.14.2 Procedure

Test the TPRD sample, applying a torque adjacent to the fitting, thereby installing it into a threaded fixture of suitable size.

For a TPRD having a threaded connection or threaded connections, apply 150 % of the maximum rated torque for 15 min to each threaded connection. Release the torque, then remove the TPRD.

7.14.3 Acceptable results

Visually examine the TPRD sample to confirm there is no deformation or breakage.

The TPRD shall meet the requirements of the leakage test specified in 7.10 and the hydrostatic strength test specified in 7.15.

7.15 Hydrostatic strength

7.15.1 Sampling

One new TPRD shall undergo this test, as well as additional TPRD samples as specified in the other performance tests.

7.15.2 Procedure

7.15.2.1 Hydrostatic testing procedure for TPRDs

A hydrostatic pressure of 250 % of the nominal working pressure shall be applied to the inlet of the TPRD at room temperature for a period of 3 min. The TPRD sample shall be visually examined to verify that rupture has not occurred.

The hydrostatic pressure shall then be increased at a rate of less than or equal to 5 % of the nominal working pressure until the TPRD bursts.

7.15.2.2 Hydrostatic procedure for pilot-activated PRD valves

For negative-acting pilot-activated PRD valves, the pilot portion of the test sample shall be pressurized at room temperature to 150 % of the pressure developed in the pressure cycling test in 7.2.

For positive-acting pilot-activated PRD valves, the pilot portion of the test sample shall be pressurized to 250 % of the pressure developed in the pilot chamber in the high flow activation test in 7.11.2. Alternatively, if the pilot pressure from 7.11.2 is not determined or deemed representative, 250 % of the nominal working pressure shall be applied to the pilot chamber.

A hydrostatic pressure per the above paragraphs shall be applied to the inlet of the component for a period of 3 min. The test sample shall be visually examined to verify that rupture has not occurred.

The hydrostatic pressure shall then be increased at a rate of less than or equal to 5 % of the nominal working pressure until the test sample bursts.

7.15.3 Acceptable results

The hydrostatic pressure at burst shall be recorded. The burst pressure of previously tested samples shall be no less than 80 % of the burst pressure of the new test sample.

7.16 Water jet protection

7.16.1 Sampling

One finished TPRD shall be subjected to the water jet protection test. This test is intended for TPRDs that can be exposed to the exterior of a vehicle, particularly where pressure-washing or road spray can be experienced and having external openings or seals when installed per the manufacturer's component literature.

NOTE TPRDs that have an IPX9K rating per ISO 20653 are considered to have met the requirements of this test.

7.16.2 Procedure

The TPRD shall be mounted as per the manufacturer's recommended procedures. The test shall be conducted at ambient temperature. If the TPRD sample is not cylindrical or similarly rotationally symmetrical, it shall be mounted on a rotating fixture turning at 10 s to 12 s per rotation or the direction of spray rotated accordingly. Water shall be sprayed using a pressure washer jet spraying at 8 MPa to 10 MPa and flow at a rate of 14 l/min to 16 l/min. The spray fan pattern shall utilize a flat stream nozzle with a spray fan angle of 15 ± 5°. The spray fan orientation, relative to the spray fan spread pattern, shall be perpendicular to the sweep direction. The jet shall come from a nozzle held at a distance of 10 cm to 15 cm and shall be at a temperature of 40 °C to 60 °C. Spraying shall occur at angles of 0°, 30°, 60°, 90°, 120°, and 150° to the symmetry axis for 30 s each.

At the completion of the spray test, the outside of the TPRD sample shall be wiped dry, and it shall be inspected for damage or water ingress.

7.16.3 Acceptable results

The TPRD shall not be damaged or otherwise rendered inoperable. Water shall not penetrate any external seals.

8 Inspection and acceptance testing

8.1 Inspection and acceptance testing plan

The TPRD manufacturer shall prepare a plan for inspection and acceptance testing. Inspections and tests may be conducted by suppliers, the TPRD manufacturer or by an independent agency.

8.2 Inspector's responsibilities

The inspector is responsible for verifying that all drawing, test and specification requirements have been met. The inspector shall select units to be tested and shall prepare or review all inspection and test reports.

8.3 Inspection of system critical components

System critical components identified in the FMEA shall be inspected using a suitable system before assembly or shipment.

Fusible components not within the manufacturer's tolerances for voids, inclusions or other harmful defects shall be destroyed.

8.4 Leak testing

All TPRDs shall be tested for leakage at both 5 % and a minimum of 125 % of the manufacturer's specified nominal working pressure. TPRDs that leak greater than 10 Ncm^3/h hydrogen or hydrogen equivalent shall be rejected. Helium or hydrogen, at any concentration, may be used to measure leakage in this test, provided the leak rate of the test gas is converted to an equivalent leak rate for hydrogen.

9 Production batch testing

9.1 General

For testing purposes, the ambient temperature shall be between 16 °C and 38 °C.

Batch testing shall be conducted on system critical components identified in the FMEA, and finished TPRDs. Batch tests of system critical components may be conducted by the supplier, an independent agency or the TPRD manufacturer. Batch tests for TPRDs may be conducted by the manufacturer or by an independent agency. Test reports shall be kept on file by the TPRD manufacturer for the design service life of the TPRD plus five years, and made available to fuel container manufacturers and end users upon request.

When the test results fail to meet the requirements, the TPRD or component batch shall be rejected. Retest of a rejected batch is authorized if the test equipment or procedure was faulty.

9.2 Production batch sizes

9.2.1 General

The size of batches for PRD components, except as specified in 9.2.2 and 9.2.3, shall be determined by the manufacturer. Batch sizes shall be consistent with good manufacturing practice and appropriate levels of inspection utilizing the results of the FMEA performed in accordance with the requirements of 6.4.

9.2.2 Fusible materials

The batch size is limited to what can be produced by one common set of raw materials (e.g. a single oven melt).

9.2.3 Pressure relief devices

The batch size is limited to what can be produced from a single batch of system critical components. The batch size shall be determined and managed under the manufacturer's quality control system.

9.3 Pressure relief device components

The PRD manufacturer shall either obtain certification from component suppliers that their components are in accordance with the appropriate specifications for materials, heat-treat, physical properties and mechanical properties, or conduct tests or inspections to confirm that the appropriate specifications have been met.

9.4 Pressure cycle verification

9.4.1 General

One PRD shall be selected at random from its batch.

9.4.2 Procedure

The PRD shall be subjected to 15 000 hydraulic pressure cycles at 20 °C from 2 MPa to not less than 125 % of the manufacturer's specified nominal working pressure.

9.4.3 Acceptable results

Following this test, the PRD sample shall not show any indication of fatigue or component damage, and shall meet the requirements of 7.10.

9.5 Bench top activation

9.5.1 General

One TPRD shall be selected at random from its batch.

9.5.2 Procedure

The TPRD shall be subjected to the appropriate bench top activation test per 7.11. The following data shall be recorded:

a) chimney temperature;

b) time to activation.

9.5.3 Acceptable results

The TPRD shall activate within 2 min of the baseline activation time as established with the design qualification bench top activation test.

10 Marking

10.1 Required information

PRDs shall be marked with the name and year of this document (i.e. ISO 19882:2025), type of gas (H2), the manufacturer's specified nominal working pressure or pressure class (H35 or H70), the manufacturer's identification, part number, and traceability code.

If it is possible to install the PRD to allow the flow in the wrong direction, it shall be marked with an arrow to show the direction of the flow.

10.2 Marking methods

Markings shall be permanent. Permanent adhesive labels are permissible, or markings may be etched or stamped onto the PRD housing.

11 Component literature

11.1 General

Manufacturers shall provide component literature for their devices. These instructions shall provide information to guide the installer in making a proper installation, and applicable concerns as identified in Annex A. The instructions shall also require that intermediate assemblers or container manufacturers who assemble a PRD to a container must transmit the warning and instructions to the installer. The manufacturer shall provide duplicate instructions in response to requests, including service parts. The instructions shall be published in the predominant language(s) of the destination country. Critical parts of the component literature shall be worded in the imperative (shall or must, not should or may).

Component literature shall include at least:

a) gasses the device is certified to;

b) maximum nominal working pressure;

c) activation temperature (except pilot-activated PRD valves);

d) flow capacity as determined by 7.12 and 7.13, or flow coefficient (Kv);

e) design cycle life or service life;

f) identification of parts requiring regular periodic replacement.

Component literature should include the following items, if applicable:

g) installation torques or similar values;

h) mounting location limitations;

i) installation orientations, if any, particularly considering the accumulation of contaminants in the high pressure or vent outlet lines;

j) vent line requirements for the flow, protection of the pressure relief device from contamination and containment of projectiles;

k) inspection procedures, if any;

l) inlet connection requirements, including minimum flow characteristics;

m) requirements for warning labels that may be required as part of the installation.

All of these requirements need only to be addressed as it affects the function of the pressure relief device. Requirements that arise from other standards, such as vent line routing, do not need to be addressed in the instructions.

11.2 Component literature recommendations for pilot-activated PRD valves

In addition to 11.1, the component literature for pilot-activated PRD valves should also include:

a) models or characteristics of PRDs that may be used as triggers for the valve;

b) the maximum number of PRDs that may be connected to a single valve, the maximum number of valves that may be connected to a single PRD, or similar data as required for proper system configuration.

All of these requirements need only be addressed as concerns the function of the PRD. Requirements that arise from other standards, such as vent line routing, do not need to be addressed in the instructions.

The manufacturer's instructions shall state that the installation shall be in accordance with the regulations of the local authority having jurisdiction (AHJ).

Annex A
(informative)

Subsystem and vehicle level considerations

A.1 Purpose

The purpose of this annex is to record the fuel container, fuel storage subsystem and vehicle level requirements. As this document is a component level standard, these recommendations are outside the scope of this document, and the pressure relief device manufacturers would not be able to demonstrate compliance if they were included in this document. In addition, the pressure relief device manufacturer does not control the usage and installation of their devices, and therefore cannot certify that they comply with the following statements.

These statements are intended as recommendations for consideration of inclusion to the organizations and committees developing these sub system and vehicle level standards, such as IEC 62282-4-101, SAE J2578 and SAE J2579.

A.2 Design service life

The design service life of the pressure relief device should meet or exceed the design service life of the fuel container with which it is used.

A.3 Design nominal working pressure

The design nominal working pressure of the pressure relief device should meet or exceed the design nominal working pressure of the fuel container for which it is used.

A.4 External environment

A.4.1 Location of pressure relief devices

The thermally reactive portion of the thermally activated pressure relief devices should be located in the same area or compartment, and should be exposed to the same environment, as the fuel container or systems that are being protected.

A.4.2 Pressure relief device cautionary labelling

Pressure relief devices that are mounted externally to the container valve assembly should have a yellow caution label affixed to them, stating that the component contains high pressure even when the service valve is closed.

A.4.3 Pressure relief device discharge vent and leakage capture systems

A.4.3.1 General

The primary function of the pressure relief device discharge vent system, if used, is to direct the discharge from a pressure relief device. The primary function of a leakage capture system, if used, is to capture potential leakage from the various connections to pressure relief devices, valves and bosses of containers and direct the gas out of the compartment to prevent a combustible mixture in a confined space.