83 Specifications of specific components for the compressed hydrogen storage system

Refer to: R134 00-S2

83.1 Effective date and Scope:

From 2017/4/1, all types of components for the hydrogen storage systems using in vehicles of category symbols M and N shall comply with this regulation.

83.2 Definitions:

83.2.1 "Burst disc" means the non-reclosing operating part of a pressure relief device which, when installed in the device, is designed to burst at a predetermined pressure to permit the discharge of compressed hydrogen.

83.2.2 "Check valve" means a non-return valve that prevents reverse flow in the vehicle fuel line.

83.2.3 "Compressed hydrogen storage system (CHSS)" means a system designed to store hydrogen fuel for a hydrogen-fuelled vehicle and composed of a pressurized container, pressure relief devices (PRDs) and shut off device(s) that isolate the stored hydrogen from the remainder of the fuel system and its environment.

83.2.4 "Container" (for hydrogen storage) means the component within the hydrogen storage system that stores the primary volume of hydrogen fuel.

83.2.5 "Date of removal from service" means the date (month and year) specified for removal from service.

83.2.6 "Date of manufacture" (of a compressed hydrogen container) means the date (month and year) of the proof

pressure test carried out during manufacture.

83.2.7 "Enclosed or semi-enclosed spaces" means the special volumes within the vehicle (or the vehicle outline across openings) that are external to the hydrogen system (storage system, fuel cell system and fuel flow management system) and its housings (if any) where hydrogen may accumulate (and thereby pose a hazard), as it may occur in the passenger compartment, luggage compartment and space under the hood.

83.2.8 "Exhaust point of discharge" means the geometric centre of the area where fuel cell purged gas is discharged from the vehicle.

83.2.9 "Fuel cell system" means a system containing the fuel cell stack(s), air processing system, fuel flow control system, exhaust system, thermal management system and water management system.

83.2.10 "Fuelling receptacle" means the equipment to which a fuelling station nozzle attaches to the vehicle and through which fuel is transferred to the vehicle. The fuelling receptacle is used as an alternative to a fuelling port.

83.2.11 "Hydrogen concentration" means the percentage of the hydrogen moles (or molecules) within the mixture of hydrogen and air (equivalent to the partial volume of hydrogen gas).

83.2.12 "Hydrogen-fuelled vehicle" means any motor vehicle that uses compressed gaseous hydrogen as a fuel to propel the vehicle, including fuel cell and internal combustion engine vehicles. Hydrogen fuel for passenger vehicles is specified in ISO 14687-2: 2012 and SAE J2719: (September 2011 Revision).

83.2.13 "Luggage compartment" means the space in the vehicle for luggage and/or goods accommodation, bounded by the roof, hood, floor, side walls, being separated from the passenger compartment by the front bulkhead or the rear bulkhead.

83.2.14 "Maximum allowable working pressure (MAWP)" means the highest gauge pressure to which a pressure container or storage system is permitted to operate under normal operating conditions.

83.2.15 "Maximum fuelling pressure (MFP)" means the maximum pressure applied to compressed system during fuelling. The maximum fuelling pressure is 125 per cent of the Nominal Working Pressure.

83.2.16 "Nominal working pressure (NWP)" means the gauge pressure that characterizes typical operation of a system. For compressed hydrogen gas containers, NWP is the settled pressure of compressed gas in fully fuelled container or storage system at a uniform temperature of 15 deg. C.

83.2.17 "Pressure relief device (PRD)" means a device that, when activated under specified performance conditions, is used to release hydrogen from a pressurized system and thereby prevent failure of the system.

83.2.18 "Rupture" or "burst" both mean to come apart suddenly and violently, break open or fly into pieces due to the force of internal pressure.

83.2.19 "Safety relief valve" means a pressure relief device that opens at a preset pressure level and can re-close.

83.2.20 "Service life" (of a compressed hydrogen container) means the time frame during which service (usage) is

authorized.

83.2.21 "Shut-off valve" means a valve between the storage container and the vehicle fuel system that can be automatically activated; which defaults to the "closed" position when not connected to a power source.

83.2.22 "Single failure" means a failure caused by a single event, including any consequential failures resulting from this failure.

83.2.23 "Thermally-activated pressure relief device (TPRD)" means a non- reclosing PRD that is activated by temperature to open and release hydrogen gas.

83.2.24 "Vehicle fuel system" means an assembly of components used to store or supply hydrogen fuel to a fuel cell (FC) or internal combustion engine (ICE).

83.3 Specifications of specific components for the compressed hydrogen storage system shall according to suitable type and range of principle：

83.3.1 The same brand and type series.

83.3.2 The same state of stored hydrogen fuel(compressed gas).

83.3.3 The same sort of component ((T)PRD, check-valve or shut-off valve).

83.3.4 The same structure, materials and essential characteristics.

83.4 Applicants apply for certification test shall provide at least necessary testing object (or the essential part of vehicle for test)

and submit the documents as below:

83.4.1 Specification documents for paragraph 83.3 and the testing object's drawings and/ or photographs.

83.4.2 Power Plant

83.4.2.1 TPRD

83.4.2.1.1 Make(s) ;

83.4.2.1.2 Type(s) ;

83.4.2.1.3 Maximum Allowable Working Pressure (MAWP) (MPa) ;

83.4.2.1.4 Set pressure ;

83.4.2.1.5 Set temperature ;

83.4.2.1.6 Blow off capacity ;

83.4.2.1.7 Normal maximum operating temperature ;

83.4.2.1.8 Nominal working pressure(s)(MPa) ;

83.4.2.1.9 Material ;

83.4.2.1.10 Description and drawing ;

83.4.2.1.11 The instructions that the inlet and outlet connections of the TPRD are connected or capped (According to paragraph 83.6.1.5) ;

83.4.2.1.12 The installation instructions for the TPRD (According to paragraph 83.6.1.9) ;

83.4.2.2 Check valve(s)

83.4.2.2.1 Make(s) ;

83.4.2.2.2 Type(s) ;

83.4.2.2.3 Maximum Allowable Working Pressure (MAWP) (MPa) ;

83.4.2.2.4 Nominal working pressure(s) (MPa) ;

83.4.2.2.5 Material ;

83.4.2.2.6 Description and drawing ;

83.4.2.2.7 The instructions that the inlet and outlet connections of the Check valve are connected or capped (According to paragraph 83.6.2.5) ;

83.4.2.2.8 All elastomers shall demonstrate resistance to ozone (According to paragraph 83.6.2.6).

83.4.2.3 Automatic shut-off valve(s)

83.4.2.3.1 Make(s) ;

83.4.2.3.2 Type(s) ;

83.4.2.3.3 Maximum Allowable Working Pressure (MAWP) (MPa) ;

83.4.2.3.4 Nominal working pressure(s) (MPa) ;

83.4.2.3.5 Material ;

83.4.2.3.6 Description and drawing ;

83.4.2.3.7 The instructions that the inlet and outlet connections of the check valve are connected or capped (According to paragraph 83.6.2.5) ;

83.4.2.3.8 All elastomers shall demonstrate resistance to ozone (According to paragraph 83.6.2.6).

83.4.3 The documents which are required when carry out this regulation.

83.5 Specifications of specific components for the compressed hydrogen storage system

83.5.1 TPRD requirements

TPRDs shall meet the following performance requirements:
(a) Pressure cycling test (paragraph 83.6.1.1)
(b) Accelerated life test (paragraph 83.6.1.2)
(c) Temperature cycling test (paragraph 83.6.1.3)
(d) Salt corrosion resistance test (paragraph 83.6.1.4)
(e) Vehicle environment test (paragraph 83.6.1.5)
(f) Stress corrosion cracking test (paragraph 83.6.1.6)
(g) Drop and vibration test (paragraph 83.6.1.7)
(h) Leak test (paragraph 83.6.1.8)
(i) Bench top activation test (paragraph 83.6.1.9)
(j) Flow rate test (paragraph 83.6.1.10)

83.5.2 Check valve and automatic shut-off valve requirements

Check valves and automatic shut-off valves shall meet the following performance requirements:
(a) Hydrostatic strength test (paragraph 83.6.2.1)

(b) Leak test (paragraph 83.6.2.2)
(c) Extreme temperature pressure cycling test (paragraph 83.6.2.3)
(d) Salt corrosion resistance test (paragraph 83.6.2.4)
(e) Vehicle environment test (paragraph 83.6.2.5)
(f) Atmospheric exposure test (paragraph 83.6.2.6)
(g) Electrical tests (paragraph 83.6.2.7)
(h) Vibration test (paragraph 83.6.2.8)
(i) Stress corrosion cracking test (paragraph 83.6.2.9)
(j) Pre-cooled hydrogen exposure test (paragraph 83.6.2.10)

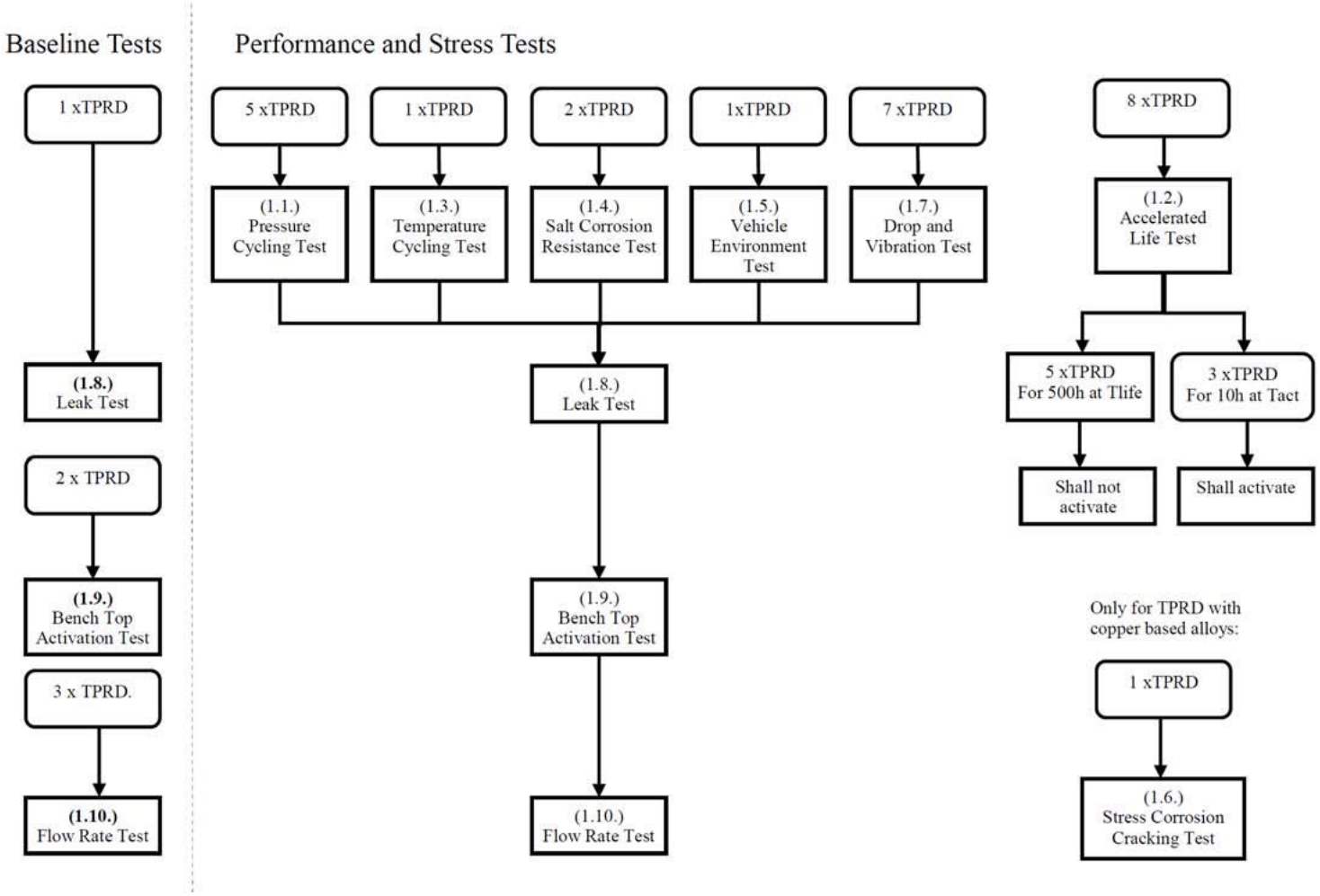
83.5.3 At least the following information: MFP and type of fuel (e.g. "CHG" for gaseous hydrogen), shall be marked on each component having the function(s) of the primary closure devices in clearly legible and indelible manner.

83.6 Test procedures for specific components for the compressed hydrogen storage system

83.6.1 TPRD Qualification Performance Tests

Testing is performed with hydrogen gas having gas quality compliant with ISO 14687-2/SAE J2719. All tests are performed at ambient temperature 20 (+/-5) deg. C unless otherwise specified. The TPRD qualification performance tests are specified as follows:

Figure 1 Overview of TPRD tests



83.6.1.1 Pressure cycling test.

Five TPRD units undergo 11,000 internal pressure cycles with hydrogen gas having gas quality compliant with ISO 14687-2/SAE J2719. The first five pressure cycles are between 2 (+/-1) MPa and 150 per cent NWP (+/-1 MPa);

the remaining cycles are between 2 (+/-1) MPa and 125 per cent NWP (+/-1 MPa). The first 1,500 pressure cycles are conducted at a TPRD temperature of 85 deg. C or higher. The remaining cycles are conducted at a TPRD temperature of 55 (+/-5) deg. C. The maximum pressure cycling rate is ten cycles per minute. Following this test, the pressure relief device shall comply the requirements of Leak test (Paragraph 83.6.1.8), Flow rate test (Paragraph 83.6.1.10) and Bench top activation test (Paragraph 83.6.1.9).

83.6.1.2 Accelerated life test.

Eight TPRD units undergo testing; three at the manufacturer's specified activation temperature, Tact, and five at an accelerated life temperature, Tlife = 9.1 x Tact0.503.

The TPRD is placed in an oven or liquid bath with the temperature held constant (+/-1 deg. C). The hydrogen gas pressure on the TPRD inlet is 125 per cent NWP (+/-1 MPa). The pressure supply may be located outside the controlled temperature oven or bath. Each device is pressured individually or through a manifold system. If a manifold system is used, each pressure connection includes a check valve to prevent pressure depletion of the system when one specimen fails. The three TPRDs tested at Tact shall activate in less than ten hours. The five TPRDs tested at Tlife shall not activate in less than 500 hours.

83.6.1.3 Temperature cycling test

(a) An unpressurized TPRD is placed in a liquid bath maintained at -40 deg. C or lower at least two hours. The TPRD is transferred to a liquid bath maintained at +85 deg. C or higher within five minutes, and maintained at that temperature at least two hours. The TPRD is transferred to a liquid bath maintained at -40 deg. C or lower within five minutes;

(b) Step (a) is repeated until 15 thermal cycles have been achieved;

(c) With the TPRD conditioned for a minimum of two hours in the -40 deg. C or lower liquid bath, the internal pressure of the TPRD is cycled with hydrogen gas between 2 MPa (+1/-0 MPa) and 80 per cent NWP (+2/-0 MPa) for 100 cycles while the liquid bath is maintained at -40 deg. C or lower;

(d) Following the thermal and pressure cycling, the pressure relief device shall comply with the requirements of Leak test (Paragraph 83.6.1.8.), except that the Leak test shall be conducted at -40 deg. C (+5/-0 deg. C). After the Leak test, the TPRD shall comply with the requirements of Bench top activation test (Paragraph 83.6.1.9.) and then Flow rate test (Paragraph 83.6.1.10.).

83.6.1.4 Salt corrosion resistance test

Two TPRD units are tested. Any non-permanent outlet caps are removed. Each TPRD unit is installed in a test fixture in accordance with the manufacturer's recommended procedure so that external exposure is consistent with realistic installation. Each unit is exposed for 500 hours to a salt spray (fog) test as specified in ASTM B117 (Standard Practice for Operating Salt Spray (Fog) Apparatus) except that in the test of one unit, the pH of the salt solution shall be adjusted to 4.0 +/- 0.2 by the addition of sulphuric acid and nitric acid in a 2:1 ratio, and in the test of the other unit, the pH of the salt solution shall be adjusted to 10.0 +/- 0.2 by the addition of sodium hydroxide. The temperature within the fog chamber is maintained at 30-35 deg. C).

Following these tests, each pressure relief device shall comply with the requirements of Leak test (paragraph 83.6.1.8.), Flow rate test (paragraph 83.6.1.10) and Bench top activation test (paragraph 83.6.1.9).

83.6.1.5 Vehicle environment test

Resistance to degradation by external exposure to automotive fluids is determined by the following test:

(a) The inlet and outlet connections of the TPRD are connected or capped in accordance with the manufacturers installation instructions. The external surfaces of the TPRD are exposed for 24 hours at 20 (+/-5) deg. C to each of the following fluids:

(i) Sulphuric acid (19 per cent solution by volume in water);

(ii) Sodium hydroxide (25 per cent solution by weight in water);

(iii) Ammonium nitrate (28 per cent by weight in water); and

(iv) Windshield washer fluid (50 per cent by volume methyl alcohol and water).

The fluids are replenished as needed to ensure complete exposure for the duration of the test. A distinct test is performed with each of the fluids. One component may be used for exposure to all of the fluids in sequence.

(b) After exposure to each fluid, the component is wiped off and rinsed with water;

(c) The component shall not show signs of physical degradation that could impair the function of the component, specifically: cracking, softening, or swelling. Cosmetic changes such as pitting or staining are not failures. At the conclusion of all exposures, the unit(s) shall comply with the requirements of Leak test (Paragraph 83.6.1.8.), Flow rate test (Paragraph 83.6.1.10.) and Bench top activation test (Paragraph 83.6.1.9.).

83.6.1.6 Stress corrosion cracking test.

For TPRDs containing components made of a copper-based alloy (e.g. brass), one TPRD unit is tested. All copper alloy components exposed to the atmosphere 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 is maintained at the bottom of the glass chamber below the sample at a concentration of at least 20 ml per litre of chamber volume.

The sample is positioned 35 (+/-5) mm above the aqueous ammonia solution and supported in an inert tray. The moist ammonia-air mixture is maintained at atmospheric pressure at 35 (+/-5) deg. C. Copper-based alloy components shall not exhibit cracking or delaminating due to this test.

83.6.1.7 Drop and vibration test

(a) Six TPRD units are dropped from a height of 2 m at ambient temperature (20 +/ - 5 deg. C) onto a smooth concrete surface. Each sample is allowed to bounce on the concrete surface after the initial impact. One unit is dropped in six orientations (opposing directions of 3 orthogonal axes: vertical, lateral and longitudinal). If each of the six dropped samples does not show visible exterior damage that indicates that the part is unsuitable for use, it shall proceed to step (b) ;

(b) Each of the six TPRD units dropped in step (a) and one additional unit not subjected to a drop are mounted in a test fixture in accordance with manufacturer's installation instructions and vibrated 30 minutes along each of the three orthogonal axes (vertical, lateral and longitudinal) at the most severe resonant frequency for each axis. The most severe resonant frequencies are determined using an acceleration of 1.5 g and sweeping through a sinusoidal frequency range of 10 to 500 Hz within 10 minutes. The resonance frequency is identified by a pronounced increase in vibration amplitude. If the resonance frequency is not found in this range, the test shall be conducted at 40 Hz. Following this test, each sample shall not show visible exterior damage that indicates that the part is unsuitable for use. It shall subsequently comply with the requirements of Leak test (Paragraph 83.6.1.8.), Flow rate test (Paragraph 83.6.1.10.) and Bench top activation test (Paragraph 83.6.1.9.).

83.6.1.8 Leak test

A TPRD that has not undergone previous testing is tested at ambient, high and low temperatures without being subjected to other design qualification tests. The unit is held for one hour at each temperature and test pressure before testing. The three temperature test conditions are:

(a) Ambient temperature: condition the unit at 20 (+/-5) deg. C; test at 5 per cent NWP (+0/-2 MPa) and 150 per

cent NWP (+2/-0 MPa);

(b) High temperature: condition the unit at 85 deg. C or higher; test at 5 per cent NWP (+0/-2 MPa) and 150 per cent NWP (+2/-0 MPa);

(c) Low temperature: condition the unit at -40 deg. C or lower; test at 5 per cent NWP (+0/-2 MPa) and 100 per cent NWP (+2/-0 MPa).

Additional units undergo leak testing as specified in other tests in Paragraph 83.6.1. with uninterrupted exposure at the temperature specified in those tests.

At all specified test temperatures, the unit is conditioned for one minute by immersion in a temperature controlled fluid (or equivalent method). If no bubbles are observed for the specified time period, the sample passes the test. If bubbles are detected, the leak rate is measured by an appropriate method. The total hydrogen leak rate shall be less than 10 Nml/hr.

83.6.1.9 Bench top activation test

Two new TPRD units are tested without being subjected to other design qualification tests in order to establish a baseline time for activation. Additional pre-tested units (pretested according to paragraphs 83.6.1.1, 83.6.1.3, 83.6.1.4, 83.6.1.5 or 83.6.1.7) undergo bench top activation testing as specified in other tests.

(a) The test setup consists of either an oven or chimney which is capable of controlling air temperature and flow to achieve 600 (+/-10) deg. C in the air surrounding the TPRD. The TPRD unit is not exposed directly to flame. The TPRD unit is mounted in a fixture according to the manufacturer's installation instructions; the test configuration is to be documented;

(b) A thermocouple is placed in the oven or chimney to monitor the temperature. The temperature remains within the acceptable range for two minutes prior to running the test;

(c) The pressurized TPRD unit is inserted into the oven or chimney, and the time for the device to activate is recorded. Prior to insertion into the oven or chimney, one new (not pre-tested) TPRD unit is pressurized to no more than 25 per cent NWP (the pre-tested); TPRD units are pressurized to no more than 25 per cent NWP; and one new (not pre-tested) TPRD unit is pressurized to 100 per cent NWP;

(d) TPRD units previously subjected to other tests in Paragraph 83.6.1. Shall activate within a period no more than two minutes longer than the baseline activation time of the new TPRD unit that was pressurized to up to 25 per cent NWP;

(e) The difference in the activation time of the two TPRD units that had not undergone previous testing shall be no

more than 2 minutes.

83.6.1.10 Flow rate test

(a) Eight TPRD units are tested for flow capacity. The eight units consist of three new TPRD units and one TPRD unit from each of the following previous tests: Annex 4, paragraphs 83.6.1.1, 83.6.1.3, 83.6.1.4, 83.6.1.5 or 83.6.1.7 ;

(b) Each TPRD unit is activated according to Paragraph 83.6.1.9 After activation and without cleaning, removal of parts, or reconditioning, each TPRD unit is subjected to flow test using hydrogen, air or an inert gas;

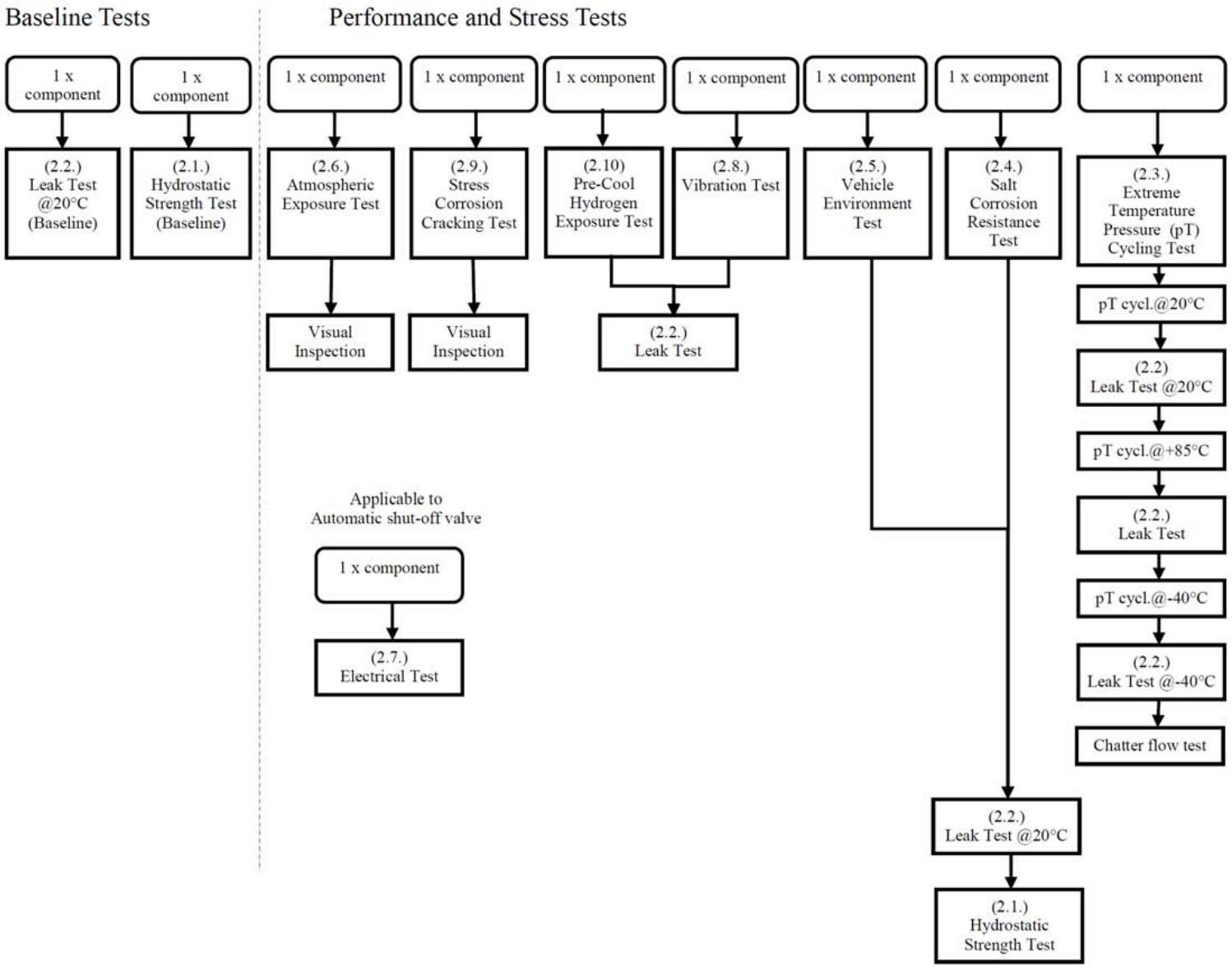
(c) Flow rate testing is conducted with a gas inlet pressure of 2 (+/-0.5) MPa. The outlet is at ambient pressure. The inlet temperature and pressure are recorded;

(d) Flow rate is measured with accuracy within +/-2 per cent. The lowest measured value of the eight pressure relief devices shall not be less than 90 per cent of the highest flow value.

83.6.2 Tests for check valve and shut-off valve

Testing shall be performed with hydrogen gas having gas quality compliant with ISO 14687-2/SAE J2719. All tests are performed at ambient temperature 20 (+/-5) deg. C unless otherwise specified. The check valve and shut-off valve qualification performance tests are specified as follows

Figure 2 Overview of check valve and automatic shut-off valve tests


Baseline Tests
Performance and Stress Tests
1 x component
1 x component
1 x component
1 x component
1 x component
1 x component
1 x component
1 x component
(2.2.) Leak Test @20°C (Baseline)
(2.1.) Hydrostatic Strength Test (Baseline)
(2.6.) Atmospheric Exposure Test
(2.9.) Stress Corrosion Cracking Test
(2.10) Pre-Cool Hydrogen Exposure Test
(2.8.) Vibration Test
(2.5.) Vehicle Environment Test
(2.4.) Salt Corrosion Resistance Test
(2.3.) Extreme Temperature Pressure (pT) Cycling Test
Visual Inspection
Visual Inspection
(2.2.) Leak Test
pT cycl.@20°C
(2.2) Leak Test @20°C
pT cycl.@+85°C
(2.2.) Leak Test
pT cycl.@-40°C
(2.2.) Leak Test @-40°C
Chatter flow test
Applicable to Automatic shut-off valve
1 x component
(2.7.) Electrical Test
(2.2.) Leak Test @20°C
(2.1.) Hydrostatic Strength Test

83.6.2.1 Hydrostatic strength test

The outlet opening in components is plugged and valve seats or internal blocks are made to assume the open position. One unit is tested without being subjected to other design qualification tests in order to establish a baseline burst pressure, other units are tested as specified in subsequent tests of Paragraph 83.6.2.

(a) A hydrostatic pressure of 250 per cent NWP (+2/-0 MPa) is applied to the inlet of the component for three minutes. The component is examined to ensure that rupture has not occurred;

(b) The hydrostatic pressure is then increased at a rate of less than or equal to 1.4 MPa/sec until component failure. The hydrostatic pressure at failure is recorded. The failure pressure of previously tested units shall be no less than 80 per cent of the failure pressure of the baseline, unless the hydrostatic pressure exceeds 400 per cent NWP.

83.6.2.2 Leak test

One unit that has not undergone previous testing is tested at ambient, high and low temperatures without being subjected to other design qualification tests. The three temperature test conditions are:

(a) Ambient temperature: condition the unit at 20 (+/-5) deg. C; test at 5 per cent NWP (+0/-2 MPa) and 150 per cent NWP (+2/-0 MPa) ;

(b) High temperature: condition the unit at 85 deg. C or higher ; test at 5 per cent NWP (+0/-2 MPa) and 150 per cent NWP (+2/-0 MPa) ;

(c) Low temperature: condition the unit at -40 deg. C or lower; test at 5 per cent NWP (+0/-2 MPa) and 100 per cent NWP (+2/-0 MPa).

Additional units undergo leak testing as specified in other tests in Paragraph 83.6.2. with uninterrupted exposure at the temperatures specified in those tests.

The outlet opening is plugged with the appropriate mating connection and pressurized hydrogen is applied to the inlet.

At all specified test temperatures, the unit is conditioned for one minute by immersion in a temperature controlled fluid (or equivalent method). If no bubbles are observed for the specified time period, the sample passes the test. If bubbles are detected, the leak rate is measured by an appropriate method. The leak rate shall not exceed 10 Nml/hr of hydrogen gas.

83.6.2.3 Extreme temperature pressure cycling test

(a) The total number of operational cycles is 11,000 for the check valve and 50,000 for the shut-off valve. The valve

unit are installed in a test fixture corresponding to the manufacturer's specifications for installation. The operation of the unit is continuously repeated using hydrogen gas at all specified pressures. An operational cycle shall be defined as follows:

(i) A check valve is connected to a test fixture and 100 per cent NWP (+2/-0 MPa) is applied in six step pulses to the check valve inlet with the outlet closed. The pressure is then vented from the check valve inlet. The pressure is lowered on the check valve outlet side to less than 60 per cent NWP prior to the next cycle;

(ii) A shut-off valve is connected to a test fixture and pressure is applied continuously to the both the inlet and outlet sides.

An operational cycle consists of one full operation and reset.

(b) Testing is performed on a unit stabilized at the following temperatures:

(i) Ambient temperature cycling. The unit undergoes operational (open/closed) cycles at 125 per cent NWP (+2/-0 MPa) through 90 per cent of the total cycles with the part stabilized at 20 (+/-5) deg. C. At the completion of the ambient temperature operational cycles, the unit shall comply with the ambient temperature leak test specified in Paragraph 83.6.2.2.;

(ii) High temperature cycling. The unit then undergoes operational cycles at 125 per cent NWP (+2/-0 MPa) through 5 per cent of the total operational cycles with the part stabilized at 85 deg. C or higher. At the completion of the 85 deg. C cycles, the unit shall comply with the high temperature (85 deg. C) leak test specified in Paragraph 83.6.2.2.;

(iii) Low temperature cycling. The unit then undergoes operational cycles at 100 per cent NWP (+2/-0 MPa) through 5 per cent of the total cycles with the part stabilized at -40 deg. C or lower. At the completion of the -40 deg. C operational shall comply with the low temperature (-40 deg. C) leak test specified in Paragraph 83.6.2.2.

(c) Check valve chatter flow test: Following 11,000 operational cycles and leak tests in Paragraph 83.6.2.3.(b), the check valve is subjected to 24 hours of chatter flow at a flow rate that causes the most chatter (valve flutter). At the completion of the test the check valve shall comply with the ambient temperature leak test (Paragraph 83.6.2.2.) and the strength test (Paragraph 83.6.2.1.).

83.6.2.4 Salt corrosion resistance test

The component is supported in its normally installed position and exposed for 500 hours to a salt spray (fog) test as specified in ASTM B117 (Standard Practice for Operating Salt Spray (Fog) Apparatus). The temperature within the fog chamber is maintained at 30 - 35 deg. C). The saline solution consists of 5 per cent sodium chloride and 95 per

cent distilled water, by weight.

Immediately after the corrosion test, the sample is rinsed and gently cleaned of salt deposits, examined for distortion, and then shall comply with the requirements of:

(a) The component shall not show signs of physical degradation that could impair the function of the component, specifically: cracking, softening or swelling. Cosmetic changes such as pitting or staining are not failures;

(b) The ambient temperature leak test (Paragraph 83.6.2.2.);

(c) The hydrostatic strength test (Paragraph 83.6.2.1.).

83.6.2.5 Vehicle environment test

Resistance to degradation by exposure to automotive fluids is determined by the following test.

(a) The inlet and outlet connections of the valve unit are connected or capped in accordance with the manufacturers installation instructions. The external surfaces of the valve unit are exposed for 24 hours at 20 (+/-5) deg. C to each of the following fluids:

(i) Sulphuric acid -19 per cent solution by volume in water;

(ii) Sodium hydroxide -25 per cent solution by weight in water;

(iii) Ammonium nitrate -28 per cent by weight in water; and

(iv) Windshield washer fluid (50 per cent by volume methyl alcohol and water).

The fluids are replenished as needed to ensure complete exposure for the duration of the test. A distinct test is performed with each of the fluids. One component may be used for exposure to all of the fluids in sequence.

(b) After exposure to each chemical, the component is wiped off and rinsed with water;

(c) The component shall not show signs of physical degradation that could impair the function of the component, specifically: cracking, softening, or swelling. Cosmetic changes such as pitting or staining are not failures. At the conclusion of all exposures, the unit(s) shall comply with the requirements of the ambient temperature leakage test (Paragraph 83.6.2.2.) and Hydrostatic Strength Test (Paragraph 83.6.2.1.).

83.6.2.6 Atmospheric exposure test

The atmospheric exposure test applies to qualification of check valve and automatic shut-off valves if the component has non-metallic materials exposed to the atmosphere during normal operating conditions.

(a) All non-metallic materials that provide a fuel containing seal, and that are exposed to the atmosphere, for which a satisfactory declaration of properties is not submitted by the applicant, shall not crack or show visible evidence of

deterioration after exposure to oxygen for 96 hours at 70 deg. C at 2 MPa in accordance with ASTM D572 (Standard Test Method for Rubber Deterioration by Heat and Oxygen);

(b) All elastomers shall demonstrate resistance to ozone by one or more of the following:

(i) Specification of elastomer compounds with established resistance to ozone;

(ii) Component testing in accordance with ISO 1431/1, ASTM D1149, or equivalent test methods.

83.6.2.7 Electrical Tests

The electrical tests apply to qualification of the automatic shut-off valve; they do not apply to qualification of check valves.

(a) Abnormal voltage test.

The solenoid valve is connected to a variable DC voltage source. The solenoid valve is operated as follows:

(i) An equilibrium (steady state temperature) hold is established for one hour at 1.5 times the rated voltage;

(ii) The voltage is increased to two times the rated voltage or 60 volts, whichever is less, and held for one minute;

(iii) Any failure shall not result in external leakage, open valve or unsafe conditions such as smoke, fire or melting.

The minimum opening voltage at NWP and room temperature shall be less than or equal to 9 V for a 12 V system and less than or equal to 18 V for a 24 V system.

(b) Insulation resistance test.

1,000 V D.C. is applied between the power conductor and the component casing for at least two seconds. The minimum allowable resistance for that component is 240 kiloohms .

83.6.2.8 Vibration test

The valve unit is pressurized to its 100 per cent NWP (+2/-0 MPa) with hydrogen, sealed at both ends, and vibrated for 30 minutes along each of the three orthogonal axes (vertical, lateral and longitudinal) at the most severe resonant frequencies. The most severe resonant frequencies are determined by acceleration of 1.5 g with a sweep time of 10 minutes within a sinusoidal frequency range of 10 to 40 Hz. If the resonance frequency is not found in this range the test is conducted at 40Hz. Following this test, each sample shall not show visible exterior damage that indicates that the performance of the part is compromised. At the completion of the test, the unit shall comply with the requirements of the ambient temperature leak test specified in Paragraph 83.6.2.2.

83.6.2.9 Stress corrosion cracking test

For the valve units containing components made of a copper-based alloy (e.g. brass), one valve unit is tested. The valve unit is disassembled, all copper-based alloy components are degreased and then the valve unit is reassembled before it is 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 is maintained at the bottom of the glass chamber below the sample at a concentration of at least 20 ml per litre of chamber volume. The sample is positioned 35 (+/-5) mm above the aqueous ammonia solution and supported in an inert tray. The moist ammonia-air mixture is maintained at atmospheric pressure at 35 (+/-5) deg. C. Copper-based alloy components shall not exhibit cracking or delaminating due to this test.

83.6.2.10 Pre-cooled hydrogen exposure test

The valve unit is subjected to pre-cooled hydrogen gas at -40 deg. C or lower at a flow rate of 30 g/sec at external temperature of 20 (+/-5) deg. C for a minimum of three minutes. The unit is de-pressurized and re-pressurized after a two minute hold period. This test is repeated ten times. This test procedure is then repeated for an additional ten cycles, except that the hold period is increased to 15 minutes. The unit shall then comply with the requirements of the ambient temperature leak test specified in Paragraph 83.6.2.2.