Comments on UN GTR 13 (Phase 1)

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Verification Test for Performance Durability (Hydraulic Sequential Tests)

- There is no tolerance specified for relative humidity during the +85°C cycles (5.1.2.6). Recommend >95% RH.
- There are no detailed test procedures for the -40°C and +85°C extreme temperature cycles including information for temperature measurements in the environment and fluid. Recommend including new Clauses 6.2.3.6 and 6.2.3.7 to describe test procedures for -40°C and +85°C extreme temperature cycles, respectively. Include suggested means for achieving >95% RH using water spray method per ISO 11119.
- Difficult to ensure that test fluids pads are wetted for the duration of the test (6.2.3.4). Recommend that a sufficient amount of the test fluid is applied to the glass wool sufficient to ensure that the pad is wetted across its surface and through its thickness for the duration of the 48 hour exposure.

Verification Test for Expected On-Road Performance (Pneumatic Sequential Tests)

- Figure 3 specifies fueling with hydrogen gas at <-35°C (5.1.3) whereas Clause 5.1.3.2 (c) specifies a hydrogen gas fueling temperature of ≤-40°C. Recommend SAE J2601 T40 fueling specification window of -33°C to -40°C within 30 seconds of fueling initiation.
- Clause 6.2.4.1 requires filling at a constant 3 minute pressure ramp rate to 87.5 MPa (± 1 MPa). For gas cycles conducted at ambient temperatures of 20°C and 50°C, this could result in an unsafe storage system condition where the state of charges exceeds 100%. For gas cycles at ambient temperatures of -40°C, the maximum fill pressure of 56 MPa yields an overly conservative fill condition. Recommend filling profiles in accordance with SAE J2601 H70T40 non-communications Table D13 (2-4 kg storage system) or Table D19 (4-7 kg storage system) or Table D25 (7-10 kg storage system).
- There is no tolerance specified for the relative humidity during +50°C cycles (5.1.3.2 (b)). Recommend >95% RH.
- The test pressure for the gas permeation test is unclear (6.2.4.2). Recommend filling the storage system to NWP at +15°C and heating the system to +55°C prior to the start of the test.
- There is no definition for steady state for the gas permeation test (6.2.4.2). Recommend steady state is achieved when three consecutive 24h readings do not fluctuate greater that 10%.
- Storage systems containing repeating element tanks, i.e. 2 or more tanks of the same dimension and component and piping configuration, should be allowed undergo a single tank pneumatic sequential test.

Verification Test for Service Terminating Performance in Fire

- Temperature profile alone is insufficient to ensure consistent heat input into the storage system. Recommend additional requirement of a minimum 100kW/m^2 heat input into the storage

system for both localized and engulfing portions of the test, or specify a burner design and LPG flow rate.

Verification test for Performance Durability of Primary Closures

- Clause 6.2.6.1.1 recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.
- Clause 6.2.6.1.2 error in the equation (missing superscript or "to the power of" symbol), i.e. Tlife = 9.1 x Tact^0.503.
- Clause 6.2.6.1.2 use of check valves to prevent pressure depletion should be optional since the failure of one sample results in the failure of the test.
- Clause 6.2.6.1.3 recommend specifying -40°C or lower, or -40°C (+0/-5°C).
- Clause 6.2.6.1.4 recommend accelerated cyclic corrosion test per ANSI HPRD 1 as this is a more representative automotive environment test.
- Clause 6.2.6.1.4 recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.
- Clause 6.2.6.1.5 unclear why sodium hydroxide and ammonium nitrate were added to vehicle environment test. Sodium hydroxide will react chemically and destroy aluminum (main body material of many PRDs) so a very difficult test if submerged (especially if conducted after sulphuric acid which affects anodized surfaces but does not cause mechanical degradation). Is this to check that aluminum coatings will prevent sulphuric acid interaction with bare aluminum? Methanol/gasoline is included in ANSI HPRD 1-2013 and ANSI HGV 3.1-2015 for vehicle crash scenarios, i.e. gasoline exposure from other cars.
- Clause 6.2.6.1.5(c) recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.
- Clause 6.2.6.1.7 recommend clarifying that "Each unit is dropped in one of the six orientations (6 units = 6 orientations).
- Clause 6.2.6.1.7(b) recommend reversing the order of final tests, i.e. Benchtop activation test then flow rate test.
- Clause 6.2.6.1.8 recommend specifying that the unit is held for a sufficient time to ensure the bulk temperature of the unit meets the temperature requirements specified below.
- Clause 6.2.6.1.8 recommend specifying that the unit is immersed in a temperature controlled fluid and monitored for leakage (or equivalent method).
- Clause 6.2.6.1.9 recommend three units instead of two to match the number of units required for the flow rate test (Clause 6.2.6.1.10).
- Clause 6.2.6.1.9(c) recommend changing to "…two new (not 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."
- Clause 6.2.6.2.2 last paragraph recommend specifying that the unit is immersed in a temperature controlled fluid and monitored for leakage (or equivalent method).
- Clause 6.2.6.2.3(a) change "the valve unit are installed…" to "the valve unit is installed…"
- Clause 6.2.6.2.3(a) (ii) This is not a proper operational cycle for a shut-off valve. Recommend using the same cycling procedure as ANSI HGV 3.1-2015 "Each duty cycle shall consist of filling through the inlet port. The inlet line shall then be depressurized. The automatic container valve

shall be opened and closed within a period of 10 ± 2 seconds. During the off cycle, the downstream pressure of the test fixture shall be reduced to 50 percent of the test pressure."

- Clause 6.2.6.2.3(c) add "hydrostatic" to "…and the hydrostatic strength test (para 6.2.6.2.1)."
- Clause 6.2.6.2.4 recommend accelerated cyclic corrosion test per ANSI HPRD 1 as this is a more representative automotive environment test.
- Clause 6.2.6.2.5(a) unclear why sodium hydroxide and ammonium nitrate were added to vehicle environment test. Sodium hydroxide will react chemically and destroy aluminum (main body material of many shut-off valves) so a very difficult test if submerged (especially if conducted after sulphuric acid which affects anodized surfaces but does not cause mechanical degradation). Is this to check that aluminum coatings will prevent sulphuric acid interaction with bare aluminum? Methanol/gasoline is included in ANSI HPRD 1-2013 and ANSI HGV 3.1-2015 for vehicle crash scenarios, i.e. gasoline exposure from other cars.
- Clause 6.2.6.2.6(a) recommend adding ISO 188 as this is a similar test procedure to ASTM D572.
- Clause 6.2.6.2.9 recommend specifying this test is only applicable to valve units containing copper-based alloys exposed to the outside environment. This is not applicable to components containing copper-based alloy internal components (not exposed to the outside environment).