SAE J 2579 Technical Information Report

Fuel Systems in Fuel Cell & Other Hydrogen Vehicles

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To Hydrogen Fuel Cell Vehicle Subgroup on Safety
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Topics

- Background
- Summary of SAE J 2579
  - General Structure
  - Guiding Principles
  - Compressed Hydrogen Performance Requirements
- Key Attributes of SAE J 2579
- Validation Testing
- Workplan for Next Steps
- Summary
Background


- Active participation by fuel cell vehicle and storage system manufacturers and testing organizations, including representation from Asia, Europe and North America.

- Existing codes including NGV2, EIHP, FMVSS 304 and CSA B51 considered, with focus to develop design-independent performance-based code.


- Two-year period for evaluation testing and workplan items with goal to publish SAE J2579 as Recommended Practice in early 2010.
SAE J 2579 – General Structure

1. Scope
2. References
3. Definitions
4. General Requirements
5. Performance Requirements
   5.1 Liquified Hydrogen
   5.2 Compressed Hydrogen

Appendices
A. Pressure Vessel Terminology
B. Material Compatibility
C. Compressed Hydrogen Qualification Tests
D. Rationale for Section 5.2 Compressed Hydrogen Requirements
E. Design and Selection of Components
F. Conducting Material Qualification Tests
G. Compressed Hydrogen System Integration
Verification of Compressed Hydrogen Storage System Performance

Demand Distribution
(Simulate Exposures in Field)

- Hydrogen
- Extreme Ambient Temperatures
- Pressure and Temperature Cycles
- Extended Static Pressure Holds
- Production and Handling Damage
- Chemical exposure
- Penetration and Fire

Capability Distribution
Typical Compressed Hydrogen System

Compressed Hydrogen Containment System

Includes all components and parts that form the primary pressure boundary for stored hydrogen

Isolates stored hydrogen from --
- the remainder of the fuel system
- the surrounding environment
Principle of “Design for Safety”

- No single-point failure should cause unreasonable risk to safety or uncontrolled vehicle behavior:
  - Fail-safe design
  - Isolation and separation of hazards to minimize cascading of events
  - Fault management with staged warnings and shutdowns

- Isolation and containment of stored hydrogen is required to practice fault management on hydrogen and fuel cell vehicles.
Section 5.2 – Compressed Hydrogen Storage System Performance Requirements

- Expected service performance test sequence (pneumatic pressure cycling)
- Durability performance test sequence (hydraulic pressure cycling)
- Performance under service-terminating conditions
Expected Service (pneumatic)

**Expected-Service Performance Verification Test**

- **Burst**
  - 180% NWP
  - 30 sec
  - 125% NWP

**Production Proof Pressure**
- 150% NWP
- 500hr +85°C

**Leak/Permeation**
- 25%cy -40°C (a)
- 25%cy +50°C (b, c)
- 125% NWP

**System Equilibration**
- @ -40°C 5cy +20°C fuel; 5cy <-35°C fuel
- @ +50°C 5cy <-35°C fuel
- Service defuel rate ≥50cy

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* a System equilibration @ -40°C 5cy +20°C fuel; 5cy <-35°C fuel
* b System equilibration @ +50°C 5cy <-35°C fuel
* c Service defuel rate ≥50cy
Durability Performance Verification Test

- **burst**  
  - <20%
- Pressure →
  - 150% NWP
  - Drop
  - Flaws & Chem
  - 48hr 125%NWP
  - #Durability Cy 125%NWP
  - 10cy T_{amb} 150%NWP
  - 30 sec 180%NWP
- Proof Pressure
  - 5.2.2.2.1
  - 5.2.2.2.2
  - 5.2.2.2.3
  - 5.2.2.1.5
  - 5.2.2.1.4
  - 5.2.3.1
Service Terminating Conditions

- **Bonfire**
  - No burst & controlled PRD release

- **Penetration**
  - No burst

- **Burst Pressure**
  - Manufacturer will establish new-vessel burst pressure

- **Cycle Life**
  - and cycle life criteria
Key Distinctions from other Pressure Vessel Codes

- System-level performance code that is independent of storage system design.
- Uses two sequences of tests (expected service and durability performance) rather than discrete testing of virgin tanks.
- Specifies end-of-life (EOL) burst margins rather than beginning-of-life (BOL) burst margins.
- In addition to requiring EOL burst margin to be at least 1.8 times maximum working pressure, also requires EOL burst pressure to be at least 80% of virgin-tank burst pressure.
- Includes pneumatic cycling and sustained stand time (in expected service sequence).
SAE J 2579 TEST PROGRAM
Results Update
Powertech contracted by SAE (funded by DOE through NREL) to validate the new SAE J2579 test procedures

Sourced 2 types of tanks at 70MPa
1. Dynetek 36L Type 3 tank
2. Lincoln 80L Type 4 tank

Test program has changed to follow the latest concerns of the committee and may continue to evolve as data is generated and issues are raised
Test Plan

1. Determine time and feasibility to perform SAE J2579 test using carbon/polymer tank (gas & hydraulic in parallel) - done
2. Subject carbon/polymer tank to the gas cycle test with end plug - done
3. Subject carbon/Al tank to the gas cycle test with end plug - done
4. Subject carbon/Al tank with valve to the gas cycle test - underway
5. Subject carbon/polymer tank to the hydraulic test - done
6. Subject carbon/Al tank to the hydraulic test - done
7. Subject glass/Al tank (with known field failure) to hydraulic test - done
8. Subject carbon/polymer tank with valve to gas cycle test - planned
Workplan for 2008 and 2009

- Complete validation testing, and revise SAE J2579 as appropriate based on findings.

- Develop localized fire test procedure(s) and performance criteria for possible inclusion in SAE J2579.

- Consider refinements to specific provisions based on additional data analyses:
  - Permeation requirements
  - Number of pressure cycles
  - Hold times and temperatures

- Criteria for redesign not requiring re-qualification.

- Re-qualification for additional service.

- Criteria for allowing parallel (versus series) performance testing.
SAE J 2579 provides performance based system level requirements to assess hydrogen storage safety while also facilitating future improvements in technology.

Validation testing scheduled for completion during 2008.

Pending successful completion of validation testing, SAE J 2579 should be considered as basis for hydrogen storage portion of FCV Global Technical Regulation.