SAE J2579 Technical Information Report

Fuel Systems in Fuel Cell & Other Hydrogen Vehicles

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To Hydrogen Fuel Cell Vehicle Subgroup on Safety

May, 2008

Topics

- Background
- Summary of SAE J2579
  - General Structure
  - Guiding Principles
  - Compressed Hydrogen Performance Requirements
- Key Attributes of SAE J2579
- Validation Testing
- Workplan for Next Steps
- Summary

Background

- Work on motor vehicle hydrogen storage system code initiated in SAE Fuel Cell Safety Work Group circa 2003.
- 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.
- SAE J2579 balloted in late 2007 and published as Technical Information Report (TIR) in January 2008.
- Two-year period for evaluation testing and workplan items with goal to publish SAE J2579 as Recommended Practice in early 2010.

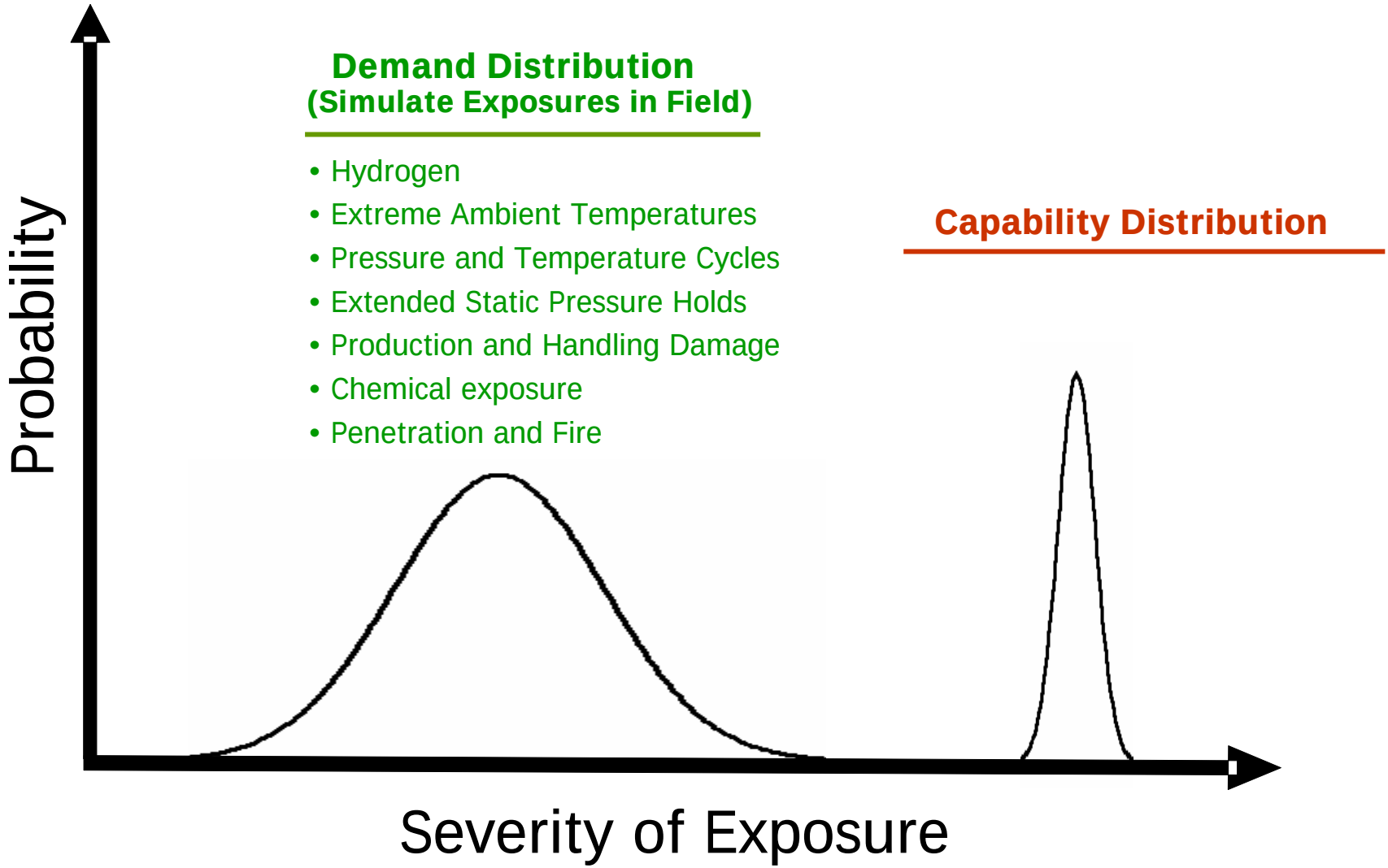
SAE J2579 – General Structure

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

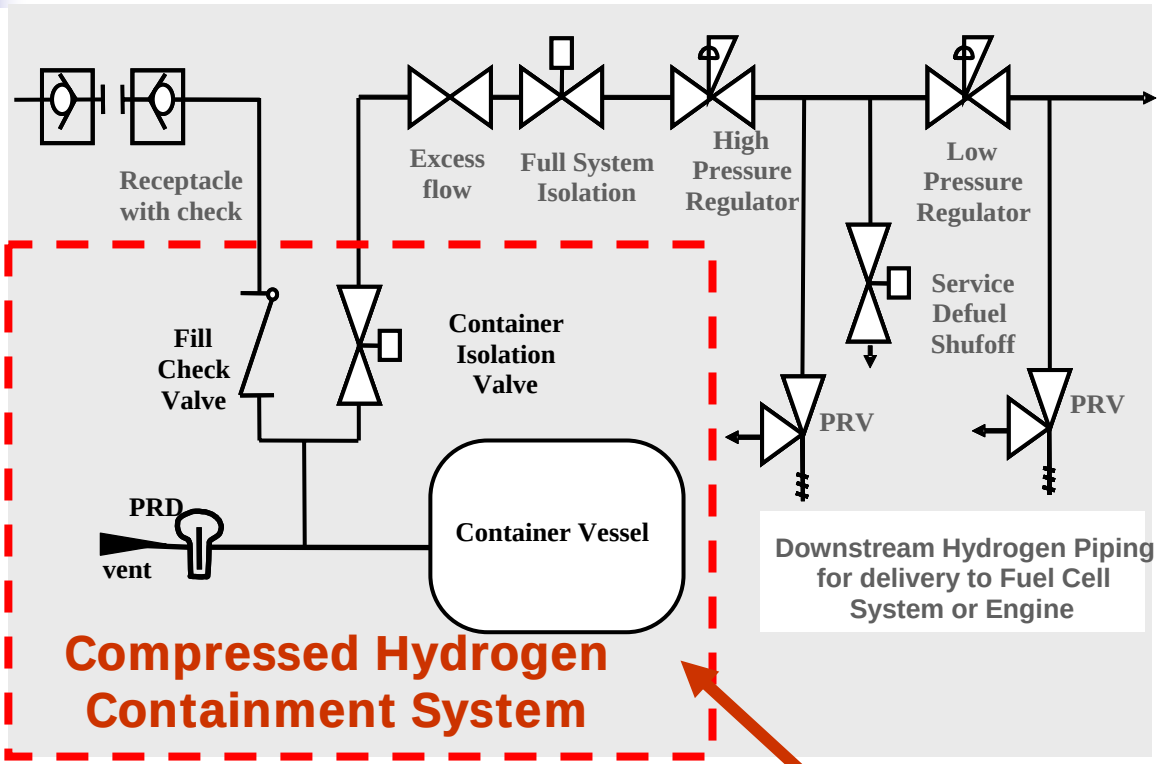
Appendices

- 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



Typical Compressed Hydrogen 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**

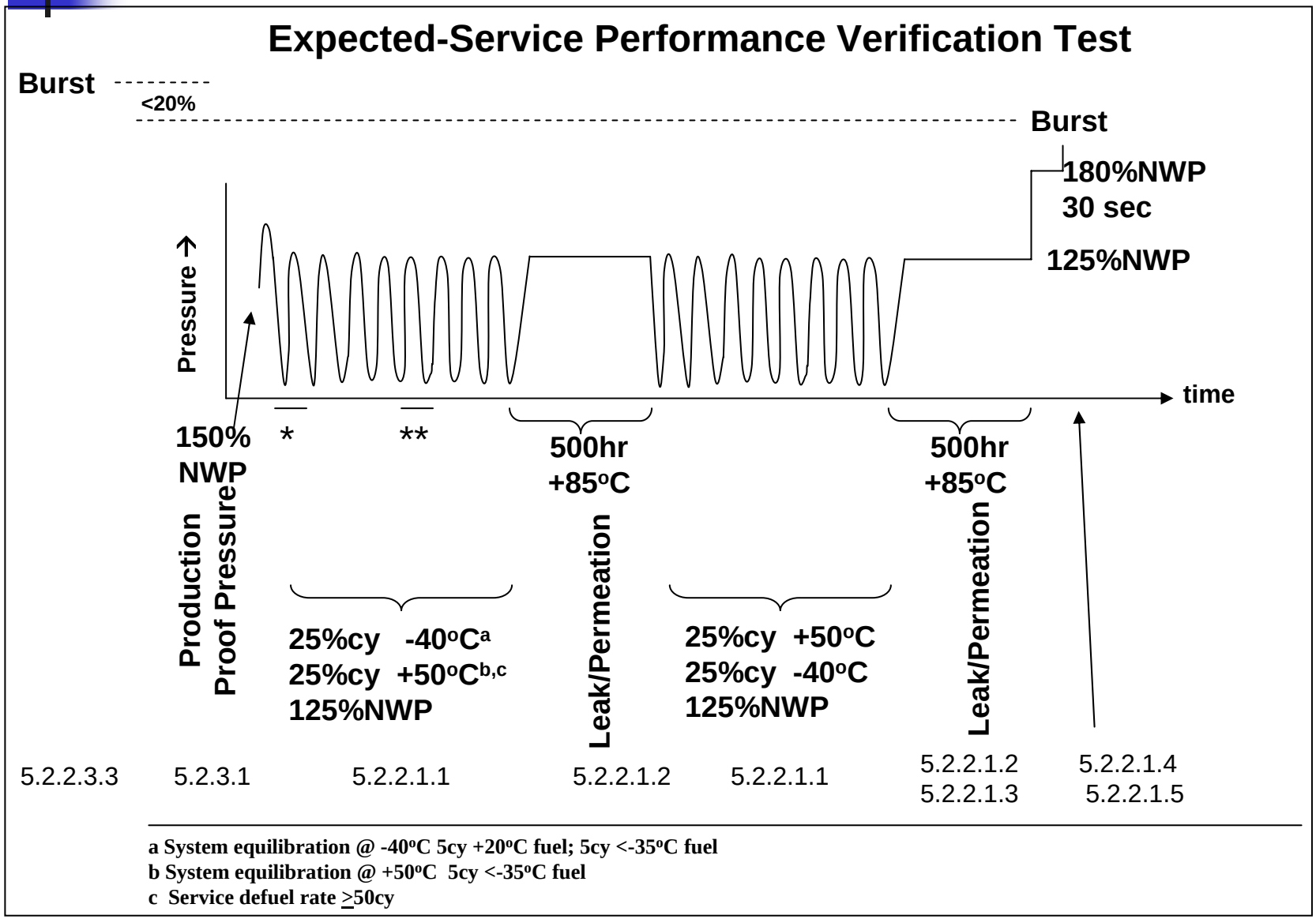
Principle of “Design for Safety”

- 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

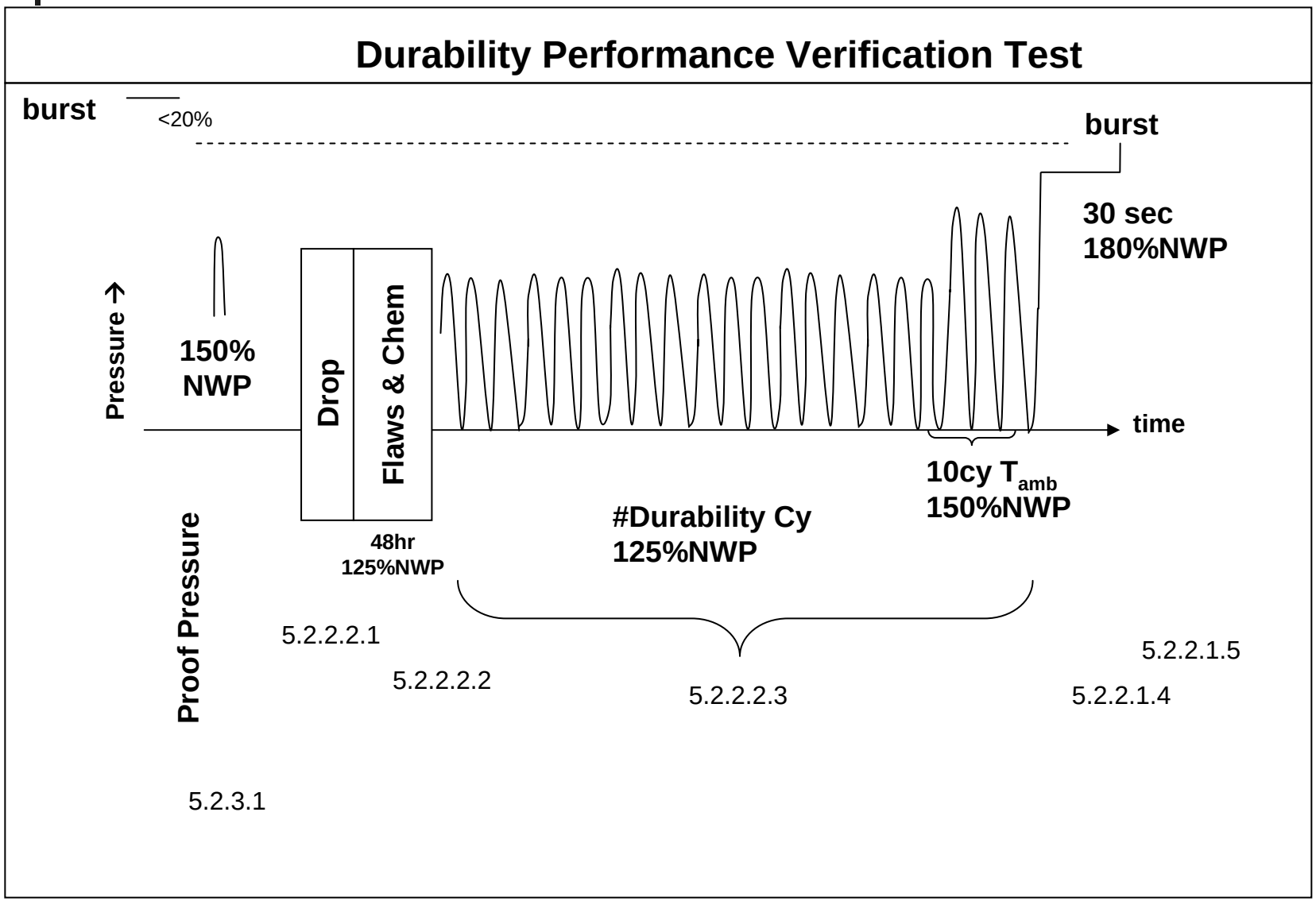
- Expected service performance test sequence (pneumatic pressure cycling)
- Durability performance test sequence (hydraulic pressure cycling)
- Performance under service-terminating conditions

Expected Service (pneumatic)



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 (hydraulic)



Service Terminating Conditions

- Bonfire — No burst & controlled PRD release
- Penetration — No burst
- Burst Pressure
- Cycle Life

Manufacturer will establish new-vessel burst pressure 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).

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SAE J2579 TEST PROGRAM
Results Update

Powertech

Project Background

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

Powertech

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

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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.

Summary

- SAE J2579 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 J2579 should be considered as basis for hydrogen storage portion of FCV Global Technical Regulation.