ANSI/AIAA S-081

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History and Participation

- Work started in 1998 to address COPV-specific needs for aerospace
- Intent to rework/update requirements in MIL-STD-1522A
- S-080 (all metal pressure vessels) started in 1996 followed by development of S-081-2000
- Requirements in S-081 for liners are based on requirements in S-080
- S-081A adopted in 2006
- Participation from NASA, DoD, FAA, commercial spacecraft/launch providers, COPV suppliers in the USA

S-081 Updates

- Addressed composite issues
  - Stress rupture
  - Impact damage
  - Material and process control requirements for composites
- Added verification requirements
  - Acceptance tests for flight tanks:
    - “transportation” proof (1.1x maximum expected operating pressure)
    - Exterior examination for visual impact sites
  - Qualification tests
    - Option to demonstrate LBB or safe-life demonstration via coupon or vessel test

Impact Damage

- USAF/NASA test program to support development of impact damage requirements
- Tests provided substantiation that impact damage reduces burst strength

Impact Damage Requirements

- Requirement to address via process control:
  - Damage control plan with risk assessment
  - Visual inspection

Or

- Requirement to address via impact damage tolerance demonstration
  - Barely visible impact damage (dependent on visual inspection)
  - Verification that a COPV with barely visible of strength requirements

Fracture Control Requirements

- ANSI-AIAA S-081 requires either leak-before-burst (LBB) or safe-life
  - Analysis or test location determined based on approach
  - Crack location and orientation must be considered
- LBB is about crack stability in the liner for an assumed crack of defined size
- Safe life is about crack depth and length growth of an NDE-defined initial crack during 4 mission duty life cycles

Review of LBB Requirements

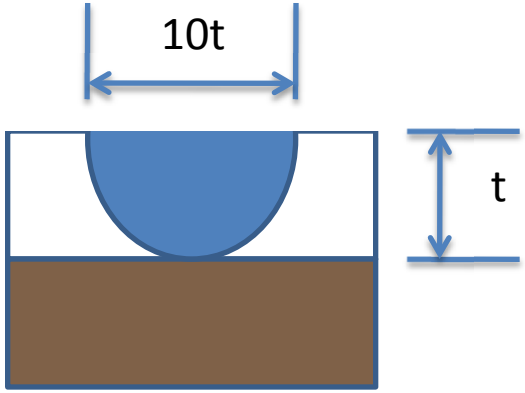
•Definition: a design approach in which, at and below MEOP, potentially pre-existing flaws in the metallic liner, should they grow, will grow through the liner and result in pressure-relieving leakage rather than burst or rupture

•Demonstrate that an initial part through crack results in K<Kc and when length is 10xthickness

•For elastically responding liner (elastic after autofrettage), LEFM approaches are acceptable

•Coupon and/or COPV testing are allowed. Coupon cracks must result in a crack with length 10xthickness. COPV tests must contain crack(s) in worst case location and LBB is demonstrated when one or more break through and result in leakage.

•Range of 0.1 to 0.5 a/2c must be used



Review of Safe-Life Requirements

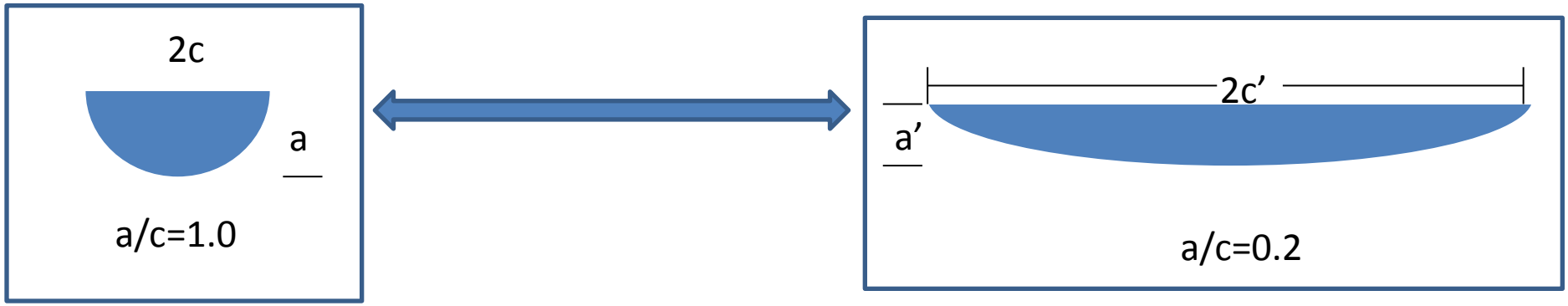
•Definition: the required period of time or number of cycles that the metallic liner of a COPV, containing the largest undetected crack shown by analysis or testing, will survive without leaking or failing catastrophically in the expected service load and environment

•Demonstrate 4xservice life with initial crack in the most critical and unfavorable orientation and defined by 90/95 POD

•For elastically responding liner (elastic after autofrettage), LEFM approaches are acceptable

•Coupon and/or COPV testing are allowed. Two surface cracks shall be tested.

•Range of 0.1 to 0.5 a/2c must be used



Stress Rupture

- The COPV shall be designed to meet the design life considering the time it is under sustained load. There shall be no credible stress rupture failure modes based on stress rupture data for a probability of survival of 0.999.
- To meet the stress rupture requirements, the lowest fiber reinforcement stress ratio at MEOP shall be: Carbon = 1.5, Aramid = 1.65, Glass = 2.25
- Other materials shall have stress rupture data and reliability analysis comparable to the materials listed above to support a given stress ratio at MEOP

Models typically used by industry to address this requirement and determine stress rupture threats for are not supported by an adequate set of experimental data

S-081A

- S-081A adopted in 2006
- Primary difference:
  - Requires demonstration by analysis or test of both LBB and safe-life

-Smaller differences:

-reliability requirement removed for stress rupture

-service life definition, autofrettage definition

-proof test hold time removed

Forward Work

- Revise S-081A to include changes in requirements for:
  - Fracture control demonstration
  - Impact damage
  - Stress rupture
  - Mechanical response verification (liner and composite)
  - Ground safety requirements