



NASA SBIR 2011 Phase I Solicitation

02.04 Advanced Tank Technology Development

Lead Center: MSFC

Participating Center(s): JSC

The objective of this subtopic is to dramatically reduce the cost of achieving low Earth orbit by advancing the technology required for spaceflight propellant tank development. The ability for launch vehicles to combine the significant weight savings of composite tanks and composite overwrap pressure vessels (COPVs) with airline like operations could be possible if these tanks are reusable, reliable, and need little to no maintenance between flights.

Composite and composite overwrap tanks offer significant weight savings, however, there are significant shortfalls in terms of reusability, especially when using cryogenic fluids. This lack of reusability severely hampers adoption of this enabling technology in future reusable vehicle designs. This subtopic seeks to mature such emerging technologies pertaining to high performance, light-weight tanks and pressure vessels suitable for cryogenic and non-cryogenic temperatures at high pressures; seeks to develop technologies that extend life and/or decrease cost while being mindful of permeability, damage tolerance, safe-life and checkout issues; and seek out seal and joint development, increasing tank robustness and life while not increasing weight or cost; all against the current state-of-the-art capabilities and technologies.

Areas of interest to develop and/or demonstrate are as follows:

- **Material Development:** New composite material development specifically for cryogenic use demonstrating cycling, reparability, and knowledge of permeability and damage tolerance. Data should clearly show materials and processes used in producing a vessel that performs well under long-term use in a cryogenic condition. Vessel performance and cycling should be analyzed at and during operational conditions (i.e., cryogenic conditions) to verify material integrity. The vessel would minimize micro cracking, should be damage tolerant and repairable, and have mounting capabilities. Permeability of the material should be addressed and evaluated against current material usage and limitations.
- **Reusability and Reliability:** Reusable, reliable, and low cost tanks that need little to no maintenance between flights and minimal check-out are required for economic and operational sustainability. These innovative propellant tank (either cryogenic or non-cryogenic) developments can:

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- Ease operability of the tank diagnostics.
 - Enable tank prognostics.
 - Enable tanks to handle high pressure cycles and loads without leaking or developing structural failure.
 - Promote ease of manufacture by more than one American company.
 - Promote ease of repair without returning tanks to the manufacturer's facility.
 - Promote rapid certification/recertification techniques to meet expected FAA commercial RLV requirements.
- Data and Technology Development: Of specific concern and interest are safe-life and damage tolerance testing. There is much scrutiny regarding the manner and degree of testing in these areas, specifically after some number of pressure cycles. Also of concern is the effect of temperature during cycling and on material integrity. Due to the limited amount of flight and long term performance data there is little to base future design on when the desire is heritage similarity. Thus, development in regards to these specific metrics (safe-life and damage tolerance testing) would be most beneficial to both short and long term missions.

For the proposed technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II hardware demonstration and testing. Delivery of a demonstration unit for NASA testing at the completion of the Phase II contract is also required.

Phase I Deliverables: Desired deliverables at the end of Phase I should be at TRL 3-4. Final report containing:

- Optimal design and feasibility of concept.
- Detailed path towards Phase II demonstration.
- Detailed results of Phase I analysis, modeling, prototyping and development testing .
- Material coupon data and a prototype sub-scale tank.

Phase II Deliverables: Deliverables expected at the end of Phase II should be at TRL 5-6. By the end of Phase II, working proof-of-concept technologies, including features and demonstration of long term, high cycle performance at cryogenic temperatures, demonstrated and delivered to NASA for testing and verification.