NASA SBIR 2015 Phase I Solicitation

H5.01 Deployable Structures

Lead Center: LaRC

Participating Center(s): GRC, JSC

This subtopic seeks deployable structures innovations in two areas for proposed deep-space space exploration missions:Â

- Large deployable solar arrays for 50+ kW solar electric propulsion (SEP) missions.
- Lightweight deployable hatches for manned inflatable structures.

Design solutions must minimize mass and launch volume while meeting other mission requirements including deployed strength, stiffness, and durability.

Innovations are sought in the following areas for both capabilities (deployable solar arrays and deployable hatches):Â

- Novel design, packaging, deployment, and in-space manufacturing or assembly concepts.
- Lightweight, compact components including booms, ribs, substrates, and mechanisms.
- Validated modeling, analysis, and simulation techniques.
- Ground and in-space test methods.
- Load reduction, damping, and stiffening techniques.
- High-fidelity, functioning laboratory models.

Capability #1: Deployable Solar Arrays

NASA is currently developing solar array systems for solar electric propulsion in the 30-50 kW power range for near-term missions such as the Asteroid Redirect Mission (ARM). This subtopic seeks structures and materials innovations for the next generation of lightweight solar arrays beyond 50 kW. NASA has a vital interest in developing much larger arrays over the next 20 years with up to 1 MW of power (4000 m^2 total deployed area) for SEP-powered exploration missions. Scaling up solar array size by over an order-of-magnitude will require game changing innovations. In particular, novel flexible-substrate designs are needed that minimize structural mass and packaging volume while maximizing deployment reliability, deployed stiffness, deployed strength, and longevity.

Nominal solar array requirements for large-scale SEP applications are:Â

- Specific power > 120 W/kg at beginning of life (BOL).
- Packaging efficiency > 40 kW/m^3 BOL.

- Deployment reliability > 0.999.
- Deployed stiffness > 0.1 Hz.
- Deployed strength > 0.1 g (all directions).
- Lifetime > 5 yrs.

Variations of NASAâ€™s in-house large solar array concept referred to as the Compact Telescoping Array (CTA) could be used for design, analysis, and hardware studies. Improved packaging, joints, deployment methods, etc. to enable CTA-type solar arrays up to 4000 m^2 in size (1 MW) with up to 250 W/kg and 60 kW/m^3 BOL are of special interest. The CTA is described in Reference 1.

Capability #2: Deployable Hatches

NASA is also seeking concepts for lightweight, deployable hatch systems for manned inflatable structures that require ingress/egress across a pressure differential. Designs should be efficient and tight-sealing and use softgoods materials in whole or in part. â€œSoftgoodsâ€ refers to advanced high-strength fabrics or woven materials. Applications of this technology include barometric chambers, airlocks and habitats, and large-scale space hangars for on-orbit assembly. The pressure vessel geometry could require hatches that conform to flat, singly-curved, or doubly-curved surfaces. Concepts will be evaluated on mass efficiency, minimal packaging volume for launch, operational reliability and simplicity, and strategy for integration into a soft-goods structure. Proposals should detail a concept of operations including packaged and deployed geometry, deployment approach, and operation of sealing/unsealing the hatch. Reference 2 provides additional information on deployable soft space structures.

Nominal hatch requirements are:Â

- 40-inch diameter clear opening for ingress/egress.
- Designed for a differential pressure of 15.2 psi.
- Hatch can be sealed and verified even when parent vessel is at vacuum.
- The hatch can be easily operated by a suited astronaut.

For both capabilities, contractors should prove the feasibility of proposed innovations using suitable analyses and tests in Phase I. In Phase II, significant hardware or software capabilities should be developed and demonstrated. A Technology Readiness Level (TRL) at the end of Phase II of 3-4 or higher is desired.

References:Â

- Mikulas, M. M. et al., â€œTelescoping Solar Array Concept for Achieving High Packaging Efficiency,â€ To be presented at the AIAA Spacecraft Structures Conference, January 2015.
- Bell L., â€œDeployable Soft Space Structures: Concepts and Application Requirements,â€ 50th AIAA Structures, Dynamics and Materials Conference, Paper 2009-2168, May 2009.Â