NASA STTR 2005 Phase I Solicitation

T7 Langley Research Center

In alliance with industry, other agencies, academia, and the atmospheric research community in the areas of aerospace vehicles, aerospace systems analysis, and atmospheric science, the Langley Research Center undertakes innovative, high-payoff activities beyond the risk limit or capability of commercial enterprises and delivers validated technology, scientific knowledge, and understanding of the Earth's atmosphere. Our success is measured by the extent to which our research results improve the quality of life of all Americans.

Subtopics

T7.01 Personal Air Transportation Technologies for Flight Demonstration

Lead Center: LaRC

NASA is performing technology research for future, on-demand, personal air transportation that is more robust and consumer focused than current commercial airline operations. The current studies involve the investigation of missions, concepts, and technologies for the purpose of augmenting on-demand personal transportation mobility and capacity over the next 20 years. The intent of this research is to perform the analyses and demonstrations required to provide radical improvements to the key metrics that currently inhibit market growth of these small, personal-use vehicles. Initial markets would build on the near-term, existing general aviation infrastructure with takeoff and landing field lengths of approximately 2500 feet. Next-generation general aviation markets will encompass a class of vehicles that have utility, comfort, public acceptance, efficiencies, cost, and ease of use which can be more closely associated with automobile-like characteristics. Long-term markets would involve mission concepts that are capable of much closer proximity operations and the ability to perform near door-to-door transportation service, but with significantly greater speed and reach.

This PAV research will include focused technology efforts leading towards the following goals and objectives:

1) Reducing small aircraft certified flyover community noise by 24 dbA from the state-of-the-art values of approximately 84 dbA while still achieving reasonable cost and efficiency with integrated vehicle concepts capable of 200-mph performance. This noise reduction equates to a tenfold reduction in the perceived noise so that these aircraft are no noisier than current motorcycle regulations. The intent of this effort is to demonstrate that significant increases in small aircraft operations can be acceptable to communities, as these vehicles are designed with

technologies that permit them to be good neighbors. These community noise reductions should also provide a significant reduction in cabin noise which will provide improved comfort levels for passengers.

2) Reducing the aircraft acquisition cost on the order of 60% from current price levels while still at relatively modest production volumes of approximately 2000 units/year. This effort will include investigation of advanced quality assurance certification processes and procedures instead of the current quality control methods. Significant industry investment has not occurred because a sizable market is not envisioned at cost levels where only a small fraction of the population can enter the market. Future production of such vehicles could be on the scale of limited production luxury cars, however the demonstration of affordable vehicles at relatively low volume is a critical step for market growth that would provide the capital for rapid expansion.

3) Simplify the operation of small aircraft such that the specialized skills, knowledge, and associated training are reduced to levels comparable to operating an automobile or boat. This reduction must be achieved during near-all-weather operations and with a level of safety that is superior to comparable operations today.

4) Additional mid-term and long-term technology investigations could also include efforts that provide improved performance, efficiency, and short field length takeoff and landing capability. Implicit to all these investigations will be enhancing the vehicle safety, versatility, ease of entry, interior environment, visibility, and maintenance and operations cost.

Research that can be demonstrated, through flight or ground experiment, will be especially helpful in establishing a credible foundation from which personal mobility technologies can proceed in the private marketplace. Information is desired on current research efforts in these focused areas for respondents interested in partnering with NASA on collaborative investigation. It is anticipated that subsystem design and testing will be performed on selected technologies or concepts.

T7.02 Non-destructive Evaluation and Structural Health Monitoring

Lead Center: LaRC

Innovative concepts are being solicited for the development of non-destructive evaluation (NDE) and health-monitoring technologies for vehicles and structures involved in exploration missions. The highest priority is structural health monitoring systems that provide real time *in situ* diagnostics and evaluation of structural integrity. Emphasis is focused on highly miniaturized, lightweight, compact systems that deliver accurate assessment of structural health. The sensors, data acquisition and analysis systems and associated electronics must perform in high stress and hostile conditions expected on launch vehicles and space environments. Diagnostic systems intended for external inspection of space vehicles and structures will be highly autonomous, remotely operated and preferably non-contacting.

Evaluation sciences include ultrasonics, laser ultrasonics, optics and fiber optics, video optics and laser metrology, thermography, electromagnetics, acoustic emission, X-ray and terahertz radiation. Innovative and novel evaluation approaches are sought for the following materials and structural systems:

- Adhesives and bonded joints, sealants, bearings, coatings, glasses, alloys, laminates, monolithics, material blends, wire insulating materials, and weldments;
- Thermal protection and insulation systems;
- Complex composite and hybrid structural systems; and
- Low-density and high-temperature materials.

Proposals should address the following performance metrics as appropriate:

- Characterization of material properties;
- Assessment of effects of defects in materials and structures;
- Evaluation of mass-loss in materials;
- Detection of cracks, porosity, foreign material, inclusions, and corrosion;
- Dis-bonded adhesive joints;
- Detection of cracks around fasteners such as bolts and rivets;
- Real-time and *in situ* monitoring, reporting, and damage characterization for structural durability and life prediction;
- Repair certification;
- Environmental sensing;
- Planetary entry aero-shell validation;
- Micro-meteor and orbital debris impact location and damage assessment;
- Electronic system/wiring integrity assessment; wire insulation integrity and condition (useful life) and arc location for failed insulation;
- Characterization of load environment on a variety of structural materials and geometries including thermal protection systems and bonded configurations;
- Identification of loads exceeding design;
- Monitoring loads for fatigue and preventing overloads;
- Suppression of acoustic loads;
- Early detection of damage; and

- *In situ* monitoring and control of materials processing.

Measurement and analysis innovations will be characterized by:

- Advanced integrated multi-functional sensor systems;
- Autonomous inspection approaches;
- Distributed/embedded sensors;
- Roaming inspectors;
- Shape adaptive sensors;
- Concepts in computational models for signal processing and data interpretation to establish quantitative characterization;
- Advanced techniques for management and analysis of digital NDE data for health assessment and lifetime prediction; and
- Biomimetic, and nano-scale sensing approaches for structural health monitoring that meet size and weight limitations for long duration space flight.