



## **NASA SBIR 2011 Phase I Solicitation**

### **A1.11 Transport Aircraft Simulator Motion Fidelity For Abnormal Flight Conditions**

**Lead Center: LaRC**

**Participating Center(s): AFRC, ARC, GRC**

Piloted simulation remains an important enabling tool for a wide variety of research aimed at commercial aviation safety. Over the past decade, significant advances in aerodynamic modeling of large transport airplanes at high angles of attack are providing new capabilities for prediction of flight behavior in off-nominal or out-of-envelope conditions. As a result, piloted simulation is now being considered for flight training specifically aimed at stall and post-stall conditions. In addition, other technology areas focused on the problem of loss-of-control accidents, such as advanced controls and crew systems, now stand to benefit from this enhanced simulation capability.

Simulator motion often plays an important role in simulator fidelity. For example, hexapod motion systems are commonly used for airline flight training and are justified by the increased transfer of training with the added realism of cockpit accelerations. However, it is recognized that all motion systems have limitations and therefore maneuvers must be designed to stay within the limits of the system's capabilities and range of effectiveness. The problem of aircraft upsets and loss-of-control typically involves large-amplitude motions due to extended excursions in vehicle attitudes and angular rates, and the desire to emulate the resulting accelerations has added a new challenge to simulator motion fidelity. A response to this need has been proposals for new motion systems that provide sustained cockpit accelerations that are possible during upset events. Over the past decade, limited research has been conducted on the effects of motion on upset training (both ground-based and in-flight simulation) and one approach has involved analysis of pilot performance with various types of training.

This subtopic requests a broad study of the requirements and capabilities for simulator motion systems across the range of current and proposed systems, including fixed-base, hexapod, continuous-g and in-flight simulation. It is intended that this research be aimed at large-amplitude motions and address simulation facility requirements for research and training or other uses for a broad range of applications and technologies. In addition, proposals for new or enhanced motion cueing systems are encouraged if justified by this study.

Desired outcomes of this research include but are not limited to the following:

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- Analysis of motion system requirements and cueing algorithms for large-amplitude maneuvers, including out-of-envelope or loss-of-control events for large transport airplanes.
  - A comparison of maneuver envelopes for current and proposed simulator motion devices.
  - Analysis of the state-of-the-art of motion systems that includes anticipated new requirements.
  - Physiological considerations for transfer of fidelity and realism of cockpit motion environments.
  - Benefits of various motion capabilities based on physiological factors, transfer of training, and other criteria as appropriate.
  - Integration of aerodynamic buffet effects and other cockpit noise and vibration sources.
  - Any other topics that are considered necessary to advance the state-of-the-art and utility of motion systems. for large amplitude maneuvers.
  - Long-term recommended research and potential advantages of advanced simulator motion fidelity.