Phase I Project Summary

Firm: Innovative Technology Applications Company, LLC
Contract Number: NNX13CL22P
Project Title: Plasma Fairings for Quieting Aircraft Landing Gear Noise

Identification and Significance of Innovation:

A major component of airframe noise for commercial transport aircraft is the deployed landing gear. This SBIR effort has worked to develop and advance a novel 'plasma fairing' technology for quieting aircraft landing gear noise. The concept of a plasma fairing involves the application of single dielectric barrier discharge (SDBD) plasma actuators (as virtual fairings) to reduce noise associated with bluff body flow separation and impingement on gear components. Previous work showed that very significant reductions in aerodynamic noise (-16 dB) could be achieved by reducing flow separations from the various components of the landing gear. The present SBIR has begun the process of advancing the plasma fairing concept to more realistic landing gear geometries. The Phase I effort consisted of a combined numerical and experimental approach using a generalized tandem cylinder configuration, which shares key features of important, high-noise sections of the Gulfstream G550 landing gear (strut and torque arm) for Phase I demonstration. This work, and the technology that arises from it, directly supports NASA's technical challenge for Quiet Low-Speed Performance under the Fixed Wing Project that aims to significantly reduce perceived community noise with minimal impact on vehicle weight and performance.

Technical Objectives and Work Plan:

- Obtain an optimized mesh for the unsteady flow using OVERFLOW
- Demonstrate a valid CFD framework for simulating the effects of plasma fairings
- Gain confidence in the prediction of plasma fairing effects on a landing gear model
- Advance the experimental investigation of plasma fairings to a more complex geometry

Technical Accomplishments:

Flow visualizations were performed to provide a global view of the effects of plasma flow control on a generalized tandem cylinder configuration. Unsteady pressure sensors were used to quantify the local behavior. The largest effect of plasma flow control was observed at a location where Cp'rms was reduced by 18% corresponding to a 5 dB reduction in SPL for low frequencies. Flow visualization shows that this reduction in surface pressure fluctuations corresponds to the transformation of the flowfield from the single slender body regime to alternate reattachment. CFD studies conducted on the same configuration reflected identical trends and flow behavior using plasma flow control. In summary, we successfully demonstrated proof of feasibility in using a plasma fairing on a more realistic landing gear configuration.

NASA Applications:

This research aims to directly address NASA technical challenge for Quiet Low-Speed Performance under the Fixed Wing Project, that is, to reduce perceived community noise by 71 dB with minimal impact on vehicle weight and performance. While the main thrust of the proposed research is to develop plasma fairings for reducing noise on an aircraft landing gear, these can be effectively configured to reduce noise caused by the wing flap and slats as well. Other potential NASA applications of the proposed plasma flow control concepts include lift enhancement and drag reduction on aircraft wings, high angle-of-attack operation using plasma actuators as lifting devices, enhanced performance and efficiency of propulsion (S-ducts, inlets) and aerodynamic (control surfaces) systems at both on- and off-design conditions, and improved cycle efficiency of NASA's air-breathing propulsion systems.

Non-NASA Commercial Applications:

Potential non-NASA applications for the plasma actuators include design of revolutionary subsonic and hypersonic aerospace vehicles for commercial and military (DoD) purposes, use in turbomachinery systems, noise-control on landing gears of commercial aircraft, design of smart wind turbine rotor blades, drag reduction on ground vehicles, smart helicopter rotor blades, tip-casing clearance flow control for reduced turbine losses, control of flow surge and stall in compressors, and turbulent transition control experiments.

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