RQ14-27

1. **Research Title:** Flameholder design and development to mitigate combustion induced instabilities

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Aerospace Engineering / Mechanical Engineering (MS or Ph.D. level)

4. **Objectives:** Research and develop innovative gas turbine combustion system flameholders to understand the flow development process, physics behind vortex shedding and to mitigate static and dynamic instabilities with efficient flame holding to reduce the weight, improve performance and fuel efficiency as governed by decreased Specific Fuel Consumption, total pressure loss and emissions. Design, Develop, model, test, and characterize the combustion system. Also part of this work is to look at novel time series data analysis techniques such as multi-fractal approach and chaotic analysis.

Description: combustors and in augmentors. In general, main combustors and augmentors utilize swirlers, fuel injectors, spray bars/spray rings and bluff body flameholders like V-gutter, triangular and strut type of concepts while modern augmentors employ close-coupled fuel injector/flameholder designs. Flame instability in practical combustion systems has been a topic of great interest due to unresolved complexities of the coupling of fluid dynamics, turbulence and chemical kinetics, with a direct influence on the combustion induced acoustics and dynamic failures, like screech and rumble. Understanding the flow field behind these flame holders in combustion systems is of great importance to design stable combustion systems, free of static and dynamic combustion instability and thermoacoustic oscillations, which are one of the least understood phenomena in combustion and a major challenge and risk in modern gas turbine engine design. In bluff-body flames, similar to those of an augmentor, hydrodynamic instabilities associated with vortex shedding and density gradients across shear layers have been identified as the source of combustion instability. Due to the dependence on vortex dynamics and the length of bluff-body reaction zones, thermoacoustic oscillations in this type of flame require experiments and Large Eddy Simulation (LES)l techniques that provide information at multiple physical scales and across a large spatial domain. The evolution of the large scale vortices, the shedding frequency and the unsteady flame dynamics in combination and the coupling between these factors dictate the thermoacoustics phenomena and the flow physics behind the flame holders and will require detailed modeling and experimentation to understand and further develop efficient flameholders for the combustion system..

5. **Research Classification/Restrictions:** This research is unclassified and unrestricted.

6. **Interest in Summer USAFA Cadet: No**

7. **Eligible Research Institutions:**

■ Universities (DAGSI & AFIT) AFIT (only) USAFA