RQ 21-80

1. **Research Title:** Large Eddy Simulations of Turbulent Combustion

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Aerospace Engineering / Mechanical Engineering / Chemical Engineering / Chemistry / Physics / Mathematics / Computer Science (MS or PhD level)

4. **Objectives:** Develop and apply new turbulent combustion modeling approaches for predicting ignition, lean blowout, and thermo-acoustic instabilities in propulsion systems operating at Air Force relevant conditions.

5. **Description:** Many existing turbulent combustion modeling and simulation approaches have been developed for and applied to steady-state reacting flows under ideal laboratory conditions. The laboratory conditions typically involve atmospheric pressures, low speed incompressible flows (i.e. low Mach numbers), low turbulence intensities (i.e. low Reynolds numbers), and gaseous fuels. Current and next-generation Air Force combustion systems operate with high pressures, high speed compressible flows (i.e. high Mach numbers), high turbulence intensities (i.e. high Reynolds numbers), and multi-component liquid fuels. Large eddy simulations (LES) and turbulent combustion models for these more relevant operating conditions require the development of new models or significant improvements to existing models such as the flamelet progress variable, linear eddy model, or transported probability density function approaches. The primary purpose of this work involves focusing on one or more of the following areas:
   (a) Evaluate and quantify the effects of numerical schemes and model assumptions at both the resolved scales and unresolved sub-grid scales in a systematic manner.
   (b) Develop models for capturing near-limit phenomena (e.g. ignition, extinction, and instability) associated with off-design combustor operation. The models should be capable of predicting the onset of lean blowout and thermo-acoustic combustion instabilities at operating conditions relevant to Air Force propulsion systems.
   (c) Evaluate the LES results using relevant experimental data such as those being acquired at the Air Force Research Laboratory Aerospace Systems Directorate Turbine Engine Division. Specific turbulent reacting flows of interest include but are not limited to bluff-body stabilized flames, swirl stabilized flames, cavity stabilized flames, and detonations.

6. **Research Classification/Restrictions:** Open to U.S. citizens only. Some aspects of this research may include ITAR restrictions.

7. **Eligible Research Institutions:** DAGSI universities

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