1. **Research Title:** Extending the Tractability of Large-Eddy Simulation for High Reynolds-Number Flows

2. **Individual Sponsor:**

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

4. **Objectives:** The proposed research will explore wall-modeled large-eddy simulation (WMLES) techniques for enabling tractable and reliable, first-principles-based simulation of high-Reynolds-number flows. The wall models will be implemented into an existing AFRL high-fidelity flow solver, FDL3DI, and their performance will be assessed for a range of test cases. Along with the models, several implicit time-integration schemes - beyond those currently available within FDL3DI - will also be implemented and investigated to further extend the stability and efficiency of the solver for relevant configurations and flow conditions.

5. **Description:** The limiting factor in the application of large-eddy simulation (LES) techniques for Air-Force-relevant configurations and conditions is the extreme resolution required for resolving the near-wall regions of the flow with increasing Reynolds number. Not only does this requirement dramatically increase the simulation's computational size, but it also forces a proportionately reduced time-step for maintaining stability of the advancing solution, which leads to longer simulation time with Reynolds number for a set physical time. To overcome the severe scaling requirements, wall-modeled LES (WMLES) methodologies have been developed, in which the near-wall region is left intentionally under-resolved by the LES, but is solved through an auxiliary wall-stress model instead. Typical wall models are of an algebraic or ordinary differential equation form over the innermost boundary layer that couples to the LES by extracting velocities on its outer edge and feeds back shear-stress values to be used as boundary conditions on the LES at the wall. The model is oftentimes only formulated in the wall-normal direction and is much more computationally tractable to solve than the full three-dimensional Navier-Stokes equations in the same region. It is also not strongly tied to the time-step of the simulation, and thus breaks the severe spatial and time-step scaling relationship at the wall with increasing Reynolds number. This feature makes WMLES a promising methodology to enable tractable first-principle-based simulation for increasingly higher Reynolds-number, relevant conditions.

6. **Research Classification/Restrictions:** This research is unclassified and for public distribution.

7. **Eligible Research Institutions:** All DAGSI Universities.

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