RQ17-15

Unsteady Aerodynamics and Heat Transfer in Turbines

1. **Research Title:** Unsteady Aerodynamics and Heat Transfer in Turbines
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**

   Mechanical or Aerospace Engineering (MS and/or PhD level)
4. **Objectives:** Develop advanced experimental and/or analytical approaches for the accurate assessment and improvement of turbine component aerodynamics and heat transfer.
5. **Description:** A current accounting of unsteady flow phenomena is critical to the successful design of turbine components. This is especially true for future systems, where it is desirable to increase engine performance and to reduce operating costs. Phenomena of current interest include vane-blade interactions, unsteady shock boundary-layer interaction, boundary-layer transition, separation control, unsteady heat transfer as a result of blade tip passage. Research opportunities in the turbine branch of the Turbine Engine Division typically have combined design, analysis, and experimental aspects. A complete design, analysis, and optimization system is in place to create advanced turbine components for validation testing in the laboratory. For example, by capitalizing on advances in transition modeling made at the laboratory, the system was used successfully to define exceptionally high lift low pressure turbine airfoils. Also, high pressure turbine components with low heat load, improved cooling effectiveness, and reduced interaction with adjacent components have been defined and validated, and we anticipate that further advances in the state-of-the-art in turbine aerothermodynamics are achievable with these design tools. Therefore, we are particularly interested in analytical work to improve and validate the design system, including improvements in optimization techniques. In addition, code improvements are now underway in the areas of advanced viscous modeling (e.g. Detached Eddy Simulation), Conjugate Heat Transfer, and multi-processor unsteady analysis for incorporation into the system. A local multi-core analysis capability is in place, and it is also possible to access computational resources at the US Air Force Major Shared Resource Center to support projects. Experimental facilities available for design system validation and other research run the gamut from low-speed wind tunnels suitable for the assessment of fundamental flow physics on flat plates and cylinders in cross-flow, to low- and high-speed linear cascades (with and without heat transfer and/or cooling) and full scale, rotating transonic turbine rigs.
6. **Research Classification/Restrictions:** Open to U.S. citizens only. Some aspects of this research may include ITAR restrictions.
7. **Eligible Research Institutions:**

   ☒ **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati)