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Development of a Cascade Research Facility to Study Gas Turbine Flow Separation and Heat Transfer

(Mechanical Engineering / Engineering and Computer Science)

The aerospace industry is continually looking for ways to improve the performance and efficiency of gas turbine engines. These efforts are traditionally focused on increasing the compressor pressure ratio and turbine inlet temperature. Increasing the compressor ratio improves the specific fuel consumption of the engine, but means that more work is required to be extracted from the flow by the turbine. The turbine spools also provide power to the other onboard systems (electronics, avionics, hydraulics, etc); there has been a trend towards increased power demand from these applications as well. The obvious way to increase turbine power output is to permit a higher inlet temperature improving cooling of the high pressure turbine which would allow more energy to be added to the flow in the combustor and subsequently more power could be generated.

The optimization of the aerodynamic performance of low pressure turbine blades is a goal that has only emerged in the last ten years. This has become necessary as aircraft are operating at higher altitudes, such as the Unmanned High Altitude Aerial Vehicles (UHAV) and new generation business jets. The low Reynolds number effects of high altitude, low temperatures, and sustained relatively low speed cruise velocities for smaller engines has shown inefficiencies due to flow separation losses within the low pressure turbine. Flow separation from low pressure turbine blades at high altitudes will continue to be a problem for modern gas turbine engines. This flow separation leads to a loss in efficiency and higher fuel consumption. Techniques must be developed to reduce or eliminate this separation.

The facility proposed in this grant would enable both of these gas turbine challenges to be addressed, that of turbine cooling and external flow separation. Cascade facilities more closely simulate the gas turbine environment and allow for more accurate representation of the conditions being investigated.