EVALUATION OF FLOW CONDITIONS DOWNSTREAM OF A TURBOFAN PROPULSION SIMULATOR FAN STAGE

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ABSTRACT

Turbofan propulsion simulators (TPS) are employed in wind tunnel tests to simulate the mutual effects between engines and airframe. TPS fan thrust is derived from gas path measurements in the fan duct downstream the fan stage. Some advanced aircraft concepts come with inherently higher intake distortions which influence these measurements. A wind tunnel test has been performed with an isolated TPS configuration to characterize the flow conditions downstream of a TPS fan stage in detail utilizing a rotational rake traversing device. Various configurational and operational parameters were varied in an experimental parametric study. Sensitivities of the flow conditions to the parameter variation have been determined.

INTRODUCTION

Current ultra-high-bypass-ratio (UHBR) turbofan engine developments are characterized by increasing bypass and decreasing fan total pressure ratios. At the same time aircraft configurations are pondered where intake distortions may increase, such as short intake or boundary layer ingestion (BLI) configurations. It is surmised that the degree of diffusion of intake distortions passing through the fan stage decreases with lower pressure ratio designs. This may have a detrimental effect on the stability of flow conditions downstream the fan stage. A powered low speed wind tunnel test has been performed to investigate the flow field downstream of an isolated turbofan propulsion simulator (TPS) fan stage scanned with a rotating rake system made of two rotating rakes equipped with five Pitot pressure and a single total temperature probe each.

RESULTS AND DISCUSSION

Various configurational (intake configuration and fan nozzle size) and operational parameters (rotational speed, wind tunnel Mach number, angle of attack) have been varied in the course of the wind tunnel test.

Apart from a detailed mapping of the total pressure distribution downstream of the fan stage, measurements in two axial locations allowed to derive the air outlet angles of the fan outlet guide vanes (OGV's). It was found that the exaggeration of the design metal angle of the stator trailing edges was chosen too high. Further it was found that the flow angles are stable with respect to configuration and operation parameter variations.

With regard to engine simulator thrust determination based on gas path measurements, sensitivities of the fan duct flow condition regarding changes in the parameters varied have been obtained.

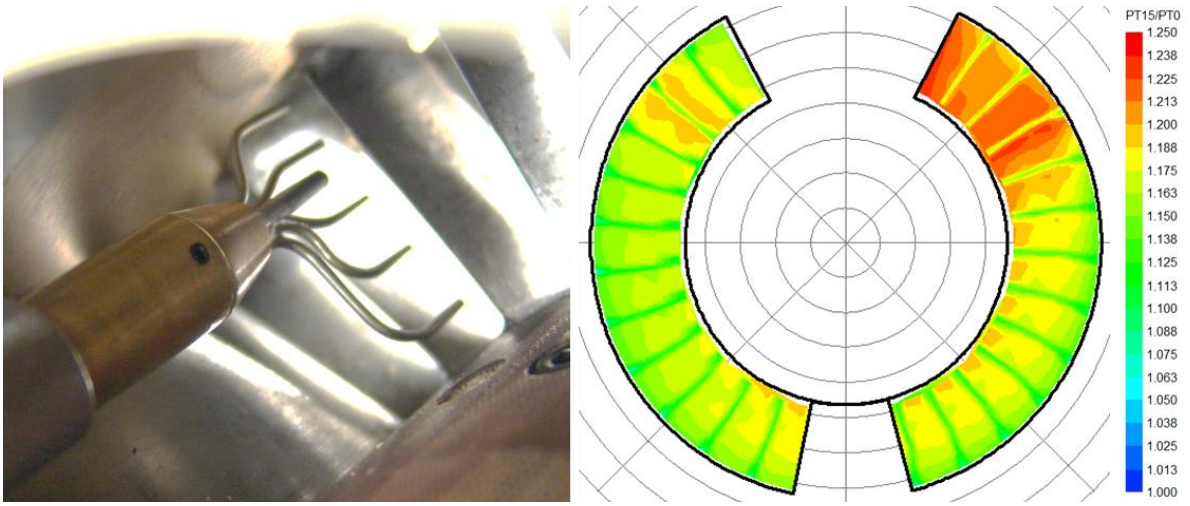

Figure 1. Rotating Rake and Total Pressure Distribution Downstream TPS fan stage

REFERENCES

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