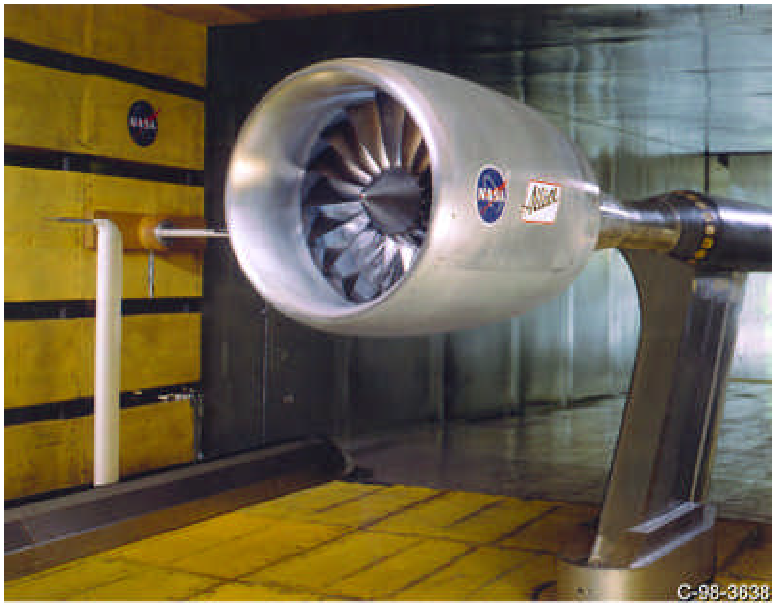
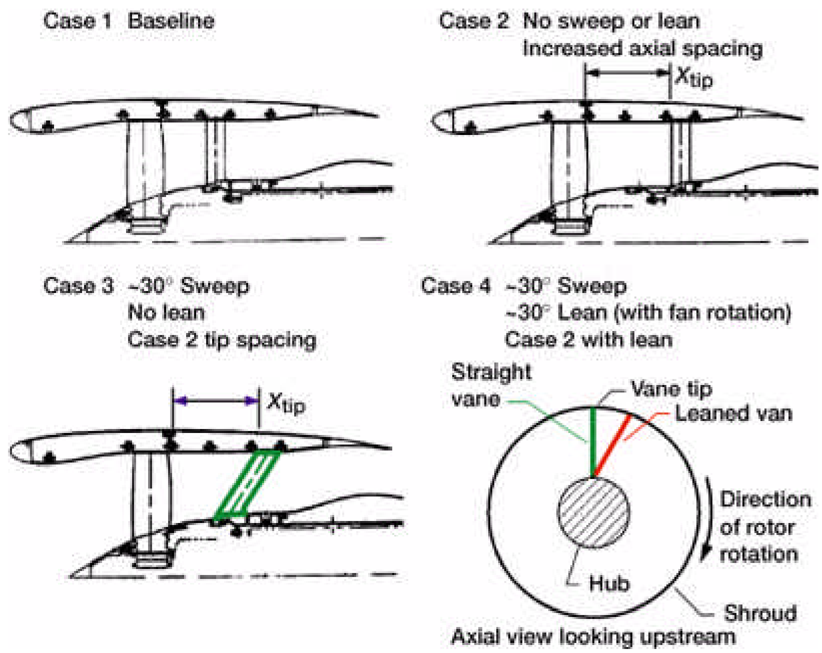
Low-Noise Potential of Advanced Fan Stage Stator Vane Designs Verified in NASA Lewis Wind Tunnel Test



NASA/Allison Engine Company Low-Noise Fan test in Lewis' 9- by 15-Foot Low-Speed Wind Tunnel.

With the advent of new, more stringent noise regulations in the next century, aircraft engine manufacturers are investigating new technologies to make the current generation of aircraft engines as well as the next generation of advanced engines quieter without sacrificing operating performance. A current NASA initiative called the Advanced Subsonic Technology (AST) Program has set as a goal a 6-EPNdB (effective perceived noise) reduction in aircraft engine noise relative to 1992 technology levels by the year 2000. As part of this noise program, and in cooperation with the Allison Engine Company, an advanced, low-noise, high-bypass-ratio fan stage design and several advanced technology stator vane designs were recently tested in NASA Lewis Research Center's 9- by 15-Foot Low-Speed Wind Tunnel (an anechoic facility). The project was called the NASA/Allison Low Noise Fan (see the figures).



NASA/Allison Low-Noise Fan test; stator vane sweep and lean.

A bypass fan stage consists of a fan and a stator vane assembly. The advanced technology bypass fan stage for this project was 22 in. in diameter and consisted of a low-pressure ratio, 18-bladed fan and an integral, 42-bladed stator vane assembly. The testing used an air turbine propulsion simulator to power the model fan stage across a wide range of operating conditions from idle to full takeoff power at a wind tunnel velocity of Mach 0.10, or about 67 knots. The main objective of the project was to evaluate the noise reduction potential of a series of advanced stator vane designs. Variations in stator vane geometry that were introduced include increasing the spacing between the fan and the stator vanes, incorporating sweep into the stator vanes (similar to aircraft wing sweep), and finally leaning the swept stator vanes over in the fan direction of rotation. During testing, the acoustic characteristics of each fan and stator vane assembly combination were measured using fixed and traversing microphones inside the wind tunnel. The aerodynamic performance of each fan/stator vane combination was also measured using pressure/temperature rakes and force balances to determine what effect the new low-noise stator vanes would have on the fan stage efficiency.

The research results generated as part of this project allowed a major interim milestone, to demonstrate a 3-EPNdB reduction in noise by 1997, to be reached for the Advanced Subsonic Technology Program. Test results will be used to create a database that engineers can draw upon for comparison with computer predictions of the effect of fan stage geometry on aircraft engine noise. In addition, aircraft manufacturers will be able to use these results to influence the design of the next generation of advanced technology aircraft engines or the next growth version of current technology engines.

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