Fan Stage Broadband Noise Benchmarking Program

Specification of Realistic Test Case 1 (RC1)
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Program Website: *http://www.oai.org/aeroacoustics/FBNWorkshop*
Information on all the test cases are available at this website.

Introduction
The purpose of this test case is to benchmark calculation methods for the prediction of the broadband noise generated by the interaction of fan rotor wake turbulence with realistic three-dimensional outlet guide vanes (OGVs). Predictions are sought for three different OGV geometries depicted in Figure 1.

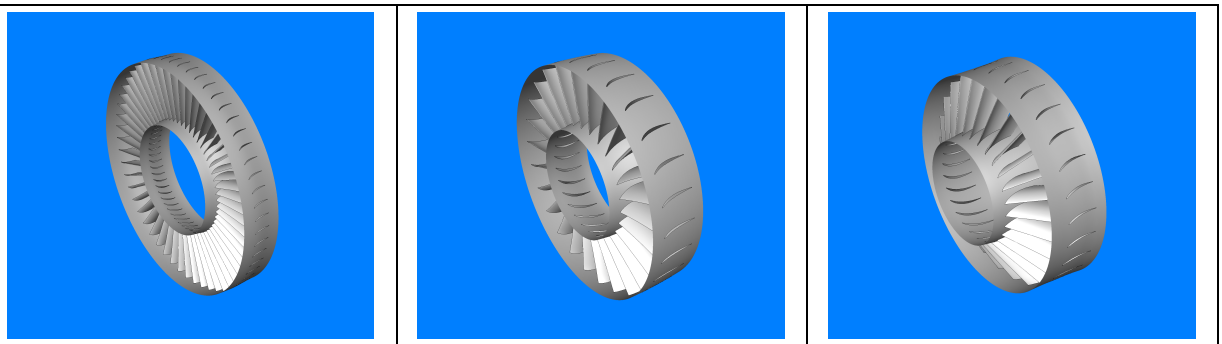

Figure 1. Benchmark OGV packs.

The geometric and aerodynamic input description of the benchmark problem will be provided by the test coordinator.

The participants interested in solving this benchmark problem must provide the narrowband spectrum of in-duct acoustic power (i.e., PWL) generated downstream of the OGV as result of the interaction of rotor turbulence with the OGV. The PWL spectral level should be expressed in dB relative to 10^{-12} Watt reference level. The range of frequencies to be considered is from 0 to 50 kHz.

Methods expected to be benchmarked for this test case include:

- Analytic blade row broadband noise models
- CAA methods using stochastic source modeling

Submission of results using other relevant methods is also welcomed.

Test Rig Description

This test case is based on the aerodynamic and acoustic data acquired for the NASA 22-inch fan rig simulator called the Source Diagnostic Test (SDT) Fan. The data was acquired at the NASA 9-foot by 15-foot Low-Speed Acoustic Wind Tunnel. A photograph and a cut-away sketch of the fan rig along with the test layout in the 9' x 15' tunnel are shown in Figure 2. For additional details regarding the 9' x 15' facility and the SDT test program consult references (1-5).

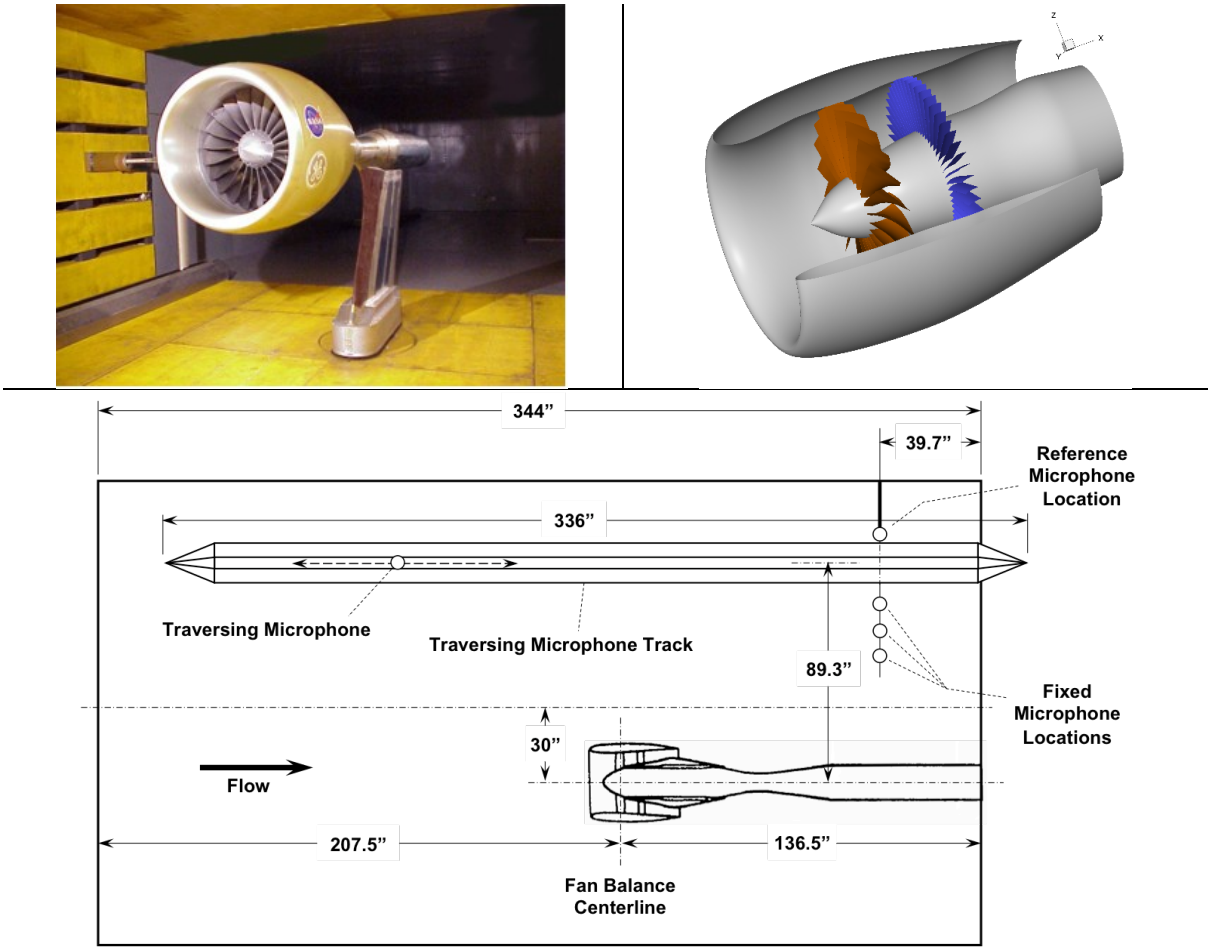

Figure 2. The Source Diagnostic Test (SDT) Fan Rig (top) and the NASA 9-foot by 15-foot Low-Speed Acoustic Wind Tunnel (bottom). Dimensions are in inches.

The input data package includes the:

- definition of the axisymmetric flowpaths inside the fan duct,
- geometric definitions for both the suction and pressures sides of the vanes,
- measured mean and turbulence velocity components as a function of the spanwise and pitchwise locations at two axial stations indicated in Figure 3. Measurements were obtained using hot wire anemometry.

The fan rpm is 7808 and its tip speed is 750 ft/s. The test condition corresponds to the approach condition for this fan stage. The fan rotor blade count is 22.

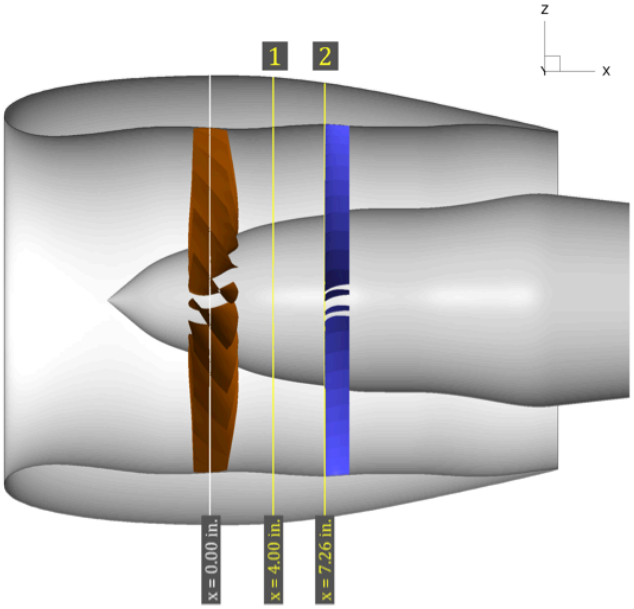

Figure 3. Mean flow and turbulent velocities data are supplied for the Station 1 (*x* = 4.00 inches) and Station 2 (*x* = 7.26 inches). All coordinates are referenced to the axial location of the fan stacking axis (*x* = 0.00 inches).

References

1. Yuska, Joseph A.; Diedrich, James H.; and Clough, Nestor: Lewis 9- by 15-Foot V/STOL Wind Tunnel. NASA TM X–2305, 1971.

2. Arrington, E. Allen; and Gonsalez, Jose C.: Flow Quality Improvements in the NASA Lewis Research Center 9- by 15-Foot Low Speed Wind Tunnel; Final Report. NASA CR–195439, 1995. Available from the NASA Center for Aerospace Information.

3. Woodward, Richard P., et al.: Background Noise Levels Measured in the NASA Lewis 9- by 15-Foot Low-Speed Wind Tunnel. NASA TM–106817 (AIAA–95–0720), 1995.

4. Hughes, C.E.: Aerodynamic Performance of Scale-Model Turbofan Outlet Guide Vanes Designed for Low Noise. AIAA–2002–374, 2002.

5. Woodward, Richard, et al.: Fan Noise Source Diagnostic Test—Far-Field Acoustic Results. AIAA–2002–2427, 2002.