National Aeronautics and Space Administration

Langley Research Center's

The Low Speed Aeroacoustic Wind Tunnel (LSAWT)

Realistic flow conditions of commercial and military aircraft engine exhausts are simulated in the anechoic environment of the Low Speed Aeroacoustic Wind Tunnel (LSAWT). Better understanding of jet-noise generation, investigation of complex flow interactions and development of noise-reduction techniques are the focus of the research conducted in this unique facility—the only one in the nation that can fully replicate the full throttle lines of every civil and military engine in service (except those operating with afterburners).

An integral part of the Jet Noise Laboratory, the LSAWT has for many years been instrumental in conducting comprehensive studies of aeroacoustic improvement technologies for jet-noise reduction for subsonic and supersonic aircraft. The facility's test rig has been upgraded to provide enhanced capability for increased temperatures and pressures.

Radiated aircraft noise results from the aircraft noise sources themselves as well as propulsion airframe aeroacoustic integration effects, among other factors. Some of the effects relevant to LSAWT test capabilities can include:

- Jet-pylon interaction effects
- Downwash-jet interaction effects
- Jet-flap interactions
- Airframe shielding of jet noise sources

Some existing technologies, such as chevron nozzles, can be further improved when the interaction effects are incorporated in order to optimize noise reduction at the system level. With increasingly challenging noise-reduction goals, consideration of system-level aeroacoustics is imperative. These same interaction effects can also be important in documenting and reducing infrared signature for military applications.

The LSAWT is comprised of an open-jet subsonic flow that models the forward flight of an aircraft during takeoff and landing. Embedded in this low-speed flow is the single/dual flow Jet Engine Simulator (JES), which can emulate separate and mixed flow turbofan engine cycles over full throttle lines. The JES provides independent control of both streams at temperatures up to 2,000 °F.





Facility Benefits

- Simulation of full throttle line conditions of all commercial and military aircraft engine exhausts (except those operating with afterburners) currently in service
- Provides platform for comprehensive studies of aeroacoustic improvement technologies for jet-noise reduction of subsonic and supersonic aircraft
- LSAWT capabilities provide for the study of:
  - Jet-pylon interaction effects
  - Downwash-jet interaction effects
  - Jet-flap interactions
  - Airframe shielding of jet noise sources

Data Acquisition and Processing

- Combined diagnostic techniques in the LSAWT enhance the physical understanding of sound-generation processes, flow fields and acoustics
- Acoustic measurements are made with a 28-microphone sideline array located 12 feet from the centerline axis of the JES where the acoustic data are presented as narrowband power spectra with a bandwidth of 25.63 Hz.
- Acoustic data are calibrated for microphone sensitivity and frequency response, and corrected for shear layer and atmospheric absorption effects

Inputs	Temperature, pressure, acoustic and dynamic
Acoustic	28 channels (permanently installed linear array--larger arrays useful for beamforming can be provided in collaboration with the Aeroacoustics Branch)
Dynamic (beside acoustic)	Available
Dynamic data acquisition	Although the sample rate, number of averages, and FFT block size are user-definable, the standard bandwidth is 25.63 Hz (using a sample rate of 210 kHz and an 8192-point FFT)
Facility frequency range	200 Hz to 100 kHz
Temperature	80 channels of thermocouples
Pressure	Pressure systems 8400 series

Instrumentation

Particle image velocimetry
Linear and phased microphone arrays
Traversing rigs available for performing surveys of temperature and pressure in the jet plume

Facility Applications

- Military aircraft testing
- Airframe evaluations
- Aircraft engine studies

Research Projects Supported

- Pylon effect experiments studying the jet-pylon and the chevron-pylon interactions
- Verification components of the modular Aircraft Noise Prediction Program (ANOPP) and its incorporation within the FAA's Environmental Design Space aircraft analysis tool
- Air and water injection for jet-noise reduction
- High temperature flow studies for military applications

Characteristics

Test section dimensions	17 ft high by 17 ft wide by 34 ft long *(5.18m high x 5.18m wide x 10.36m long)*
Free jet speed	100 to 365 ft/s (Mach Numbers from 0.1 to 0.32)
Jet engine simulator	Dual independent streams
• Nozzle pressure ratios	Up to 12
• Mass flows	2 to 20 lbm/s per stream
• Flow temperatures	Up to 2,000 °F
Classified capability	Yes
Test gas	Compressed air supplied by center air distribution system

Contact Information

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