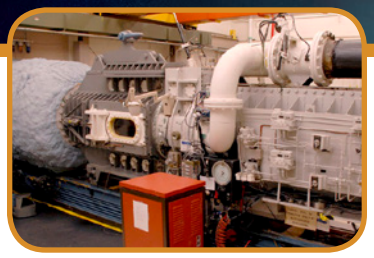
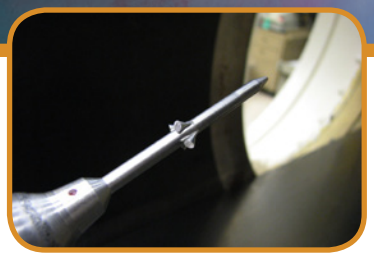
National Aeronautics and Space Administration

Marshall Space Flight Center
Aerodynamic Research Facility

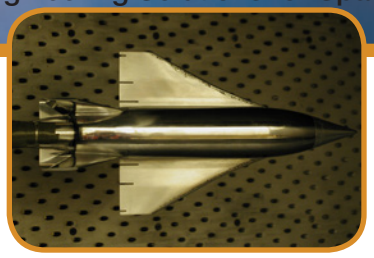
Engineering Solutions for Space Science and Exploration



ARF.



Ares Launch Abort System.



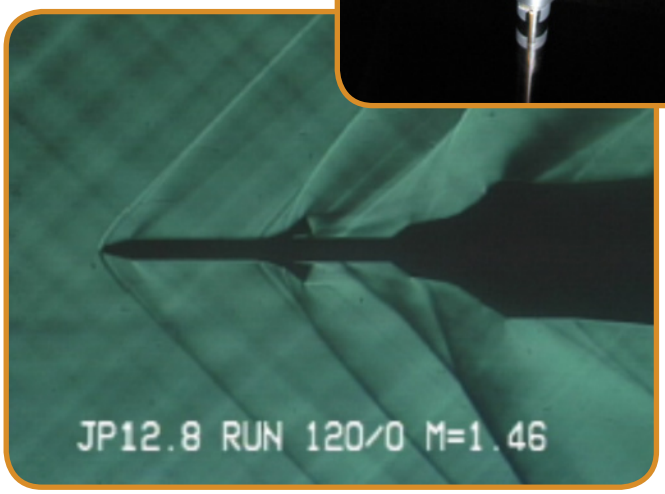
Early Space Shuttle Orbitor Concepts.

STS Full Stack Oil Flow Test.

Aerodynamic Research Facility (ARF)

can provide a low cost test alternative relative to much larger test facilities for early database development of aerospace systems. Being a trisonic facility (subsonic/transonic/supersonic speeds are attainable), a broad range of Mach numbers from 0.25 to 5 is available. The mode of operation is intermittent blowdown that operates by high-pressure air flowing from storage tanks to either vacuum or atmospheric conditions with typical run times of up to 1 min (for Mach = 2.5) or 30–40 sec for higher Mach numbers.

Two interchangeable test sections are necessary to satisfy the large Mach number range. The transonic test section is used to produce Mach numbers from 0.25 to 2.5 and contains variable porosity perforated walls. Nozzle sets consist of a 'sonic' block for Mach numbers up to 1.3. Alternate fixed-contour blocks generate additional Mach numbers of 1.46, 1.69, 1.96, and 2.46.



The supersonic test section uses solid walls and variable contour plates positioned by hydraulic jackscrews to provide Mach numbers from 2.74 to 5 in nominally 0.25 increments. Subscale test articles on the order of 16 in long may be accommodated in either test section depending on the blockage and/or anticipated loads. It only takes about 30 min to change from one test section to the other or replace the fixed contour nozzle blocks using the overhead crane, and typically the test article remains in place during this activity.

A hydraulically actuated pitch sector with a range of –10 to +10 degrees is downstream of the test section. Sting offsets are available for obtaining maximum angles of attack up to 40 degrees. Additionally, angles between 0 and 180 degrees can be obtained by using special side- and nose-mounted arrangements. Roll attitudes are adjusted manually.

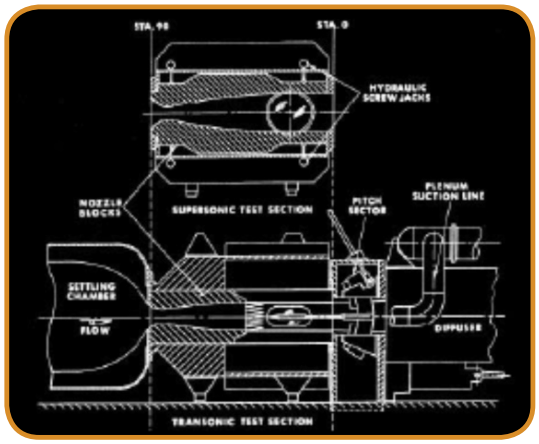
Recent improvements have been made to the tunnel's data acquisition and controls systems for increased efficiency. A National Instruments LabVIEW-based architecture provides controls automation and data sampling rates at 2,000 Hz. Near real-time processing makes the experimental data available within seconds following a run or blow, and network connections readily provide this information to the analysts.

ARF Specifications

Type of tunnel	Intermittent blowdown to atmosphere or vacuum
Test section size	Height: 14 in Width: 14 in Length: 24 in
Mach number	Transonic test section with controllable diffuser, variable porosity perforated walls, suction, and interchangeable fixed-contour, nozzle blocks. Mach: 0.25 to 1.3, 1.46, 1.69, 1.96, 2.46 Supersonic test section with solid walls and variable contour plates. Mach: 2.74 to 4.95
Reynolds number	1 to 18 million per ft
Stagnation pressure	22 to 105 psia
Dynamic Pressure	2 to 20 psia
Stagnation temperature	Ambient to 200 °F, Normally, 100 °F (transonic) or 140 °F (supersonic).
Air storage	6,000 ft^3 at 515 psia and 100 °F
Vacuum storage	42,000 ft^3 at 0.1 psia
Run time	60–90 sec (transonic) 45–50 sec (supersonic)
Recharge time	10–20 min nominally (transonic) 15–20 min (supersonic) Supplemental charging may be done with 3,500 psi plant air, when needed.
Run rate	20–30 runs per 8-hr shift
Angle of attack	–10 to +10 degrees with added range provided by offset stings up to 90 degrees.

Key Benefits

- The ARF can provide a low-cost test alternative relative to much larger test facilities for early database development of aerospace systems.
- High-speed data acquisition systems can record up to 250,000 samples per second. High-speed visible and thermal imaging can record up to 50,000 feet per second.
- Full life-cycle testing and evaluation capabilities from materials development and proof-of-concept articles up to qualification of integrated systems.
- Budget analysis and risk management available in-house.
- Workforce and facility flexibility to meet customer needs.



14-in Wind Tunnel Specifications.

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