Exhaust System Experiments at NASA’s AeroAcoustic Propulsion Lab

**Synopsis:** This presentation gives an overview of the planned testing in the AeroAcoustic Propulsion Lab (AAPL) in the coming 15 months. It was stressed in the presentation that these are plans that are subject to change due to changes in funding and/or programmatic direction. The first chart shows a simplified schedule of test entries with funding sponsor and dates for each. In subsequent charts are pages devoted to the Objectives and Issues with each test entry, along with a graphic intended to represent the test activity. The chart for each test entry also indicates sponsorship of the activity, and a contact person.
Exhaust System Experiments at NASA’s AeroAcoustics Propulsion Lab

Presented to Acoustics Technical Working Group
James Bridges
21-22 April 2011
Cleveland, OH
AeroAcoustic Propulsion Lab Schedule

- Includes activities from Supersonics and Subsonic Fixed Wing Projects
- Tests in FY12 are tentative pending funding

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N+2 System Validation Nozzle Tests

• Three-Stream Mixer-Ejector
  – Lockheed/RR-Liberty Works
  – Test begun 21 April at NATR
  – Current empirical codes predict success
  – RANS design of ejector crucial
  – RANS acoustic code prediction coming

• Inverted Velocity Profile w/Fluid Shield
  – Lockheed/GE Global
  – Test hardware in fab; test in May at NATR
  – Current empirical jet noise codes outside range of validity
  – RANS acoustic code prediction coming
  – LES underway at GE
Three-Stream Jet Noise Database

- Objectives: Provide database of far-field jet noise from simple three-stream jet flows; develop semi-empirical jet noise prediction module and validate RANS-based acoustic codes for axisymmetric 3-stream jets.
- Issues: Limited range of area ratios/ mass flow ratios with existing hardware.

Three-stream jet rig in AAPL/NATR

Basic Three-stream model

Henderson, Bridges
PAJE11 (Plasma Arc Jet Excitation)

- Jet Instability Manipulation for Noise Reduction
  - High-energy plasma actuators at nozzle lip
  - Azimuthal modes/ frequencies excited
  - Test of scaleup underway on NATR
  - 8 actuators on 1” jet (OSU) → 48 actuators on 6.5” jet (NATR)
  - Recent tests worked out issues with EMI, installation in NATR
  - End-to-end test inconclusive; diagnostics required

Supersonics Project

Brown

Actuators operating during PAJE11

PAJE11 2007-2013
**Objective:** Show cross-facility validation of same hardware in two jet rigs across cycle regime. Acquire ultra-high BPR jet noise with integration effects.

**Issue:** NATR has had internal noise from flow conditioning; JNL has had high background levels. Neither could test configurations in SFW N+3 concepts.

**Recent improvements with Dutch weave screens for flow conditioning in NATR.**

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**Subsonic Fixed Wing Project**

**HXFII (High-Flow Cross-Facility Test)**

- 1” jet on plenum pressure drop rig —90°
- 0.25”
- Dynapore™
- 450661
- Coarse side
- 0.1”
- Dynapore™
- 450661
- Fine side

![Graph](image-url)
Objective: Show cross-facility validation of same hardware in two jet rigs across cycle regime. Acquire ultra-high BPR jet noise with integration effects.

Issue: NATR has had internal noise from flow conditioning; JNL has had high background levels. Neither could test configurations in SFW N+3 concepts.

Recent improvements with Dutch weave screens for flow conditioning in NATR.

Measured approach cycle flows at BPR=8 nozzles in SBIR test in August 2010

Clean, axisymmetric noise down to NPR=1.2
• Objectives: Explore critical jet-surface configurations; hot jet data for reflecting configurations, phased array from more observer angles, obtain turbulent flow statistics and surface-pressure statistics; guide RANS-based modeling efforts and validate LES.

• Issues: Near-surface PIV; high frequency pressure-sensitive paint technology

Pressure-sensitive paint during JSIT 1  Brown, Podboy
TwinRect (Twin Rectangular Jets)

- Objectives: Far-field acoustics: Acquire far-field noise for select ERN11 nozzles; explore how rectangular nozzle geometries modify twin-jet spectral directivities; PIV: Acquire turbulent velocity data for select TWN10 configurations, and ERN11, ERN12 nozzles; document flow for code validations.
- Issues: Downselect ERN11 nozzles; include JSIT?

NA4B2 tested in 2010

Bridges

Bozak, Henderson
Objectives: Further explore spectral directivity of high aspect ratio nozzles based on ERN11 results, and CFD; acquire PIV of turbulent flow fields for code validations.

Issues: Maturity of RANS-based acoustic codes, speed of CFD gridding