Recent Innovations in Community Noise Reduction (CNR)

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National Aeronautics and Space Administration

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Aeronautics and Space Engineering Board

Environmentally Responsible Aviation
Focused research on CNR & Fuel Burn Redux (FBR)

	Integrated Technology Demonstrators 2010-16	Partner
FBR	AFC Enabled Vertical Tail and Advanced Wing Flight Experiment	Boeing
FBR	Damage Arresting Composites Demonstration (Large Scale Structural Tests)	Boeing
CNR	Adaptive Compliant Trailing Edge Flight Test (w/AFRL)	FlexSys
FBR	Highly Loaded Front Block Compressor Demonstration (WT Tests)	General Electric
CNR & FBR	2nd Generation UHB Propulsor Integration (Design, WT Tests, w/FAA)	Pratt & Whitney
NOx	Fuel Flexible, Low NOX Combustor Integration (Design, Tests)	Pratt & Whitney
CNR	Landing Gear and Flap Edge Noise Reduction Flight Tests	Gulfstream/ Inhouse
CNR & FBR	UHB Integration on Hybrid Wing Body Aircraft (Design, WT Tests)	Boeing
CNR & FBR	Advanced Open Rotor Design and WT Testing for Low Noise	General Electric
CNR & FBR	Hybrid Wing Body Low Speed Noise Reduction WT Testing (several)	Boeing/Inhouse

ERA Databases Continue to Inform the Possible NASA CNR Efforts performed at A/C System Level

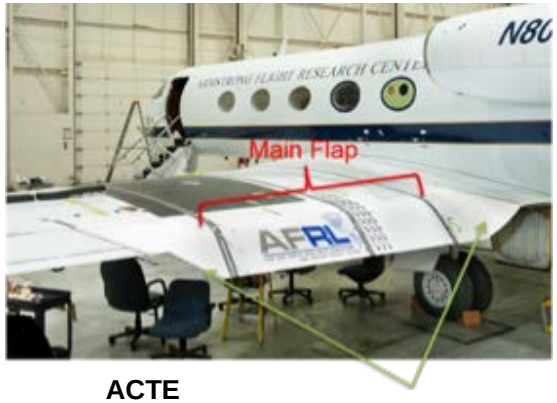
Recent A/C Assessments thru 2019	Result below Stage 4	
• Hybrid Wing Body (300 seat class)	40.4 to 50.9 dB cum.	Published Results
• Mid Fuselage Nacelle (300 seat class)	34.2 to 40.2 dB cum.	
• Advanced Tube and Wing (300 seat class)	24.3 to 30 dB cum.	
• Double Bubble (150 seat class)	9 to 15 dB cum.	
• Transonic Truss Braced Wing (150 seat class)	Work in progress (WIP)	
• Boeing B737 Max	WIP - Comparison w/cert data	
• Boeing B787 ecoDemonstrator	WIP - Comparison w/source & cert data	

Continuous upgrades to ANOPP and ANOPP II via new and improved modules and ongoing Noise Reduction (NR) technology maturation efforts

Recent NR Technology Maturation Efforts
Adaptive Compliant Trailing Edge/Main Landing Gear

- **Adaptive Compliant Trailing Edge (ACTE)**
  - Technology developed jointly by the U. S. Air Force Research Laboratory (AFRL), FlexSys, Inc., and the NASA ERA project
  - Eliminates flap side edges and bracket assemblies
- **MLG NR Technologies**
  - MLG fairings
    - Upper porous knee fairing → 7,735 holes of 0.080″ (2mm) diameter
    - Lower porous knee fairing → 3,597 holes of 0.080″ (2mm) diameter
    - Total of 11,332 drilled holes
  - Chevron/batting plate cavity treatment
  - Mesh cavity treatment

Chevron/foam cavity treatment



ACTE

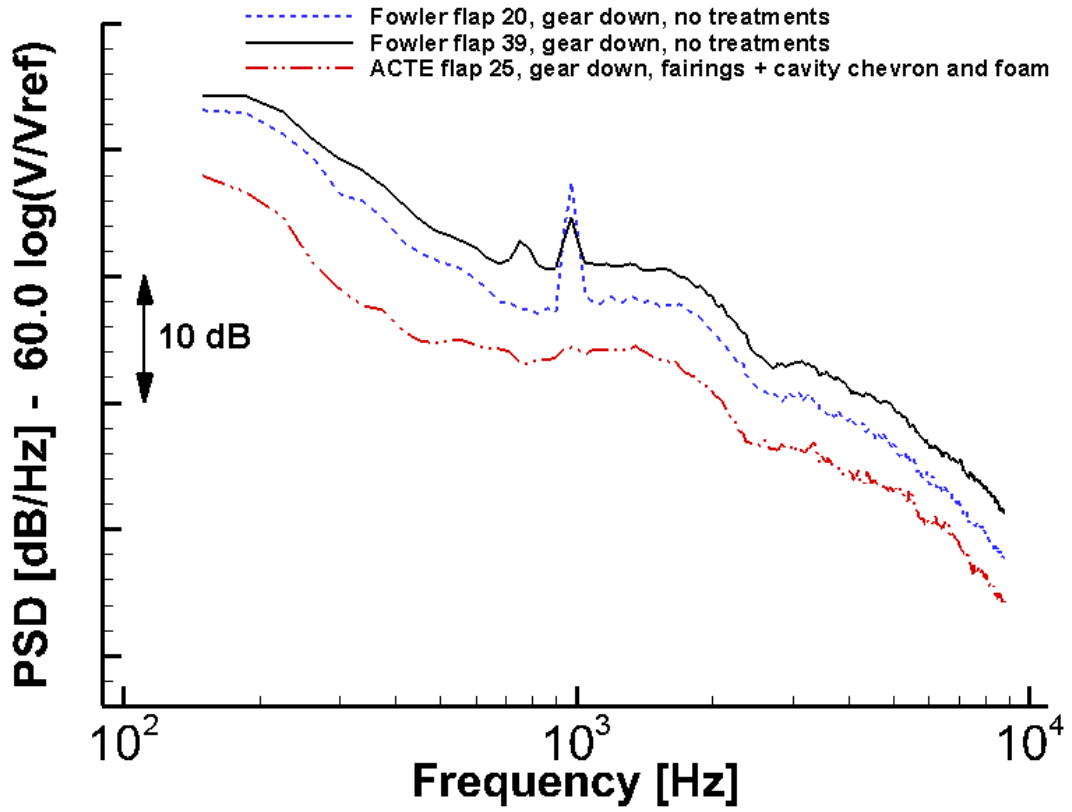
MLG fairings

Untreated MLG

Mesh cavity treatment

Recent NR Technology Maturation Efforts
Adaptive Compliant Trailing Edge/Main Landing Gear

Total Reduction in Airframe Noise



Recent NR Technology Maturation Efforts
Low Drag Acoustic Liner

Quiet Technology Demonstrator 3

- 31 hours of total flight test time
- Half dedicated to flights over phased array located at Moses Lake, WA

Low Drag Acoustic Liner

- 7 years development time in NASA facilities
- 30 percent less drag than conventional acoustic liner
- 0.5 to 1 EPNdB aircraft level noise reduction
- Enables shorter inlets desired for adv. UHB engines

Backups

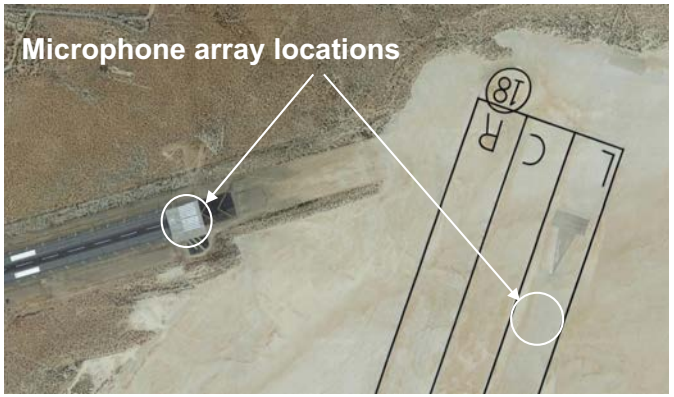
Recent NR Technology Maturation Efforts
Adaptive Compliant Trailing Edge/Main Landing Gear

- **SubsoniC Research Aircraft Testbed (SCRAT), also known by its tail number as "804"**
  - Highly instrumented testbed
  - Three spanwise strips of steady pressure ports
  - Recording of aircraft parameters (e.g., true airspeed, AOA, engine settings)
  - Recording of aircraft position (GPS)

- **Second G-III aircraft "808"**
  - Flown in its baseline (Fowler flaps, no gear treatments) configuration
  - Except for recording of GPS data, no other instrumentation onboard
  - Indicated airspeed (IAS) called out by pilots
  - Acoustic data used only for preliminary assessment of baseline noise levels

Recent NR Technology Maturation Efforts
Adaptive Compliant Trailing Edge/Main Landing Gear

- **First flight test (Aug. – Oct. 2016)**
  - Conducted on a lakebed at Edwards AFB, CA (Mojave Desert)
    - Determined engine noise contamination
    - Assessed suitability of local weather conditions
  - Evaluate aeroacoustic performance of ACTE technology



- **Second flight test (Aug. – Oct. 2017)**
  - Conducted on a lakebed at Edwards AFB
  - Evaluate acoustic performance of MLG and cavity NR concepts on 804 G-III aircraft in combination with ACTE technology
    - Accurate evaluation of gear technologies without contamination from flap noise

Overall, 47 flights and ≈ 1,100 passes over array (>90% good)

- **Third flight test (March – May 2018)**
  - Conducted on an inactive runway at Edwards AFB
  - Acquire baseline noise data on 804
  - Evaluate acoustic performance of MLG and cavity NR concepts on 804 after conversion to its original (Fowler) flap configuration
    - Evaluation of noise reduction capability of gear technologies for conventional flaps