Engine Stand Data for Flight Deck and Community Noise Predictions

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Military Noise Challenges

• Community Noise
  – Impact of airbases on surrounding community
  – Can impact/limit operations at airbases
  – Can have a financial impact

• Flight Deck (Near-Field) Noise
  – Impact of high intensity noise on flight deck personnel
  – Health issue
  – Has a financial impact

• Accurate Prediction and Quantification of Noise
Standard Challenges

• Are we making the measurements we need to address the military noise challenges?

• Where is the line between standard measurements and research?
Community Noise

Naval Station Norfolk Chambers Field

Joint Land Use Study (JLUS)/Air Installations Compatible Use Zones (AICUZ) Planning Map 2010
Flight Deck Noise Environment

Carrier Deck Qualifications
Options for Addressing Military Noise Challenges

- **Laboratory Scale Measurements**
  - Anechoic environment
  - Controlled experiments
    - Isolate effects
    - Employ range of diagnostic techniques
  - Limited exhaust temperatures, forward flight, scale
  - Flow may be “ideal” relative to full-scale engine exhaust

- **Engine Stand Measurements**
  - Realistic exhaust conditions with all turbomachinery effects
  - No scaling issues
  - No forward-flight or installation effects
  - Not anechoic and environmental effects always present
  - Limitation on diagnostics

- **Flight Measurements**
  - Capture all effects
    - difficult to isolate individual effects
  - Limited diagnostic tools
  - Error band larger

Cost, Realism, Development Stage
Use of Engine Stand Data for Military Noise Challenges

• Community noise predictions
  – Quantify source then use information in flight path/propagation program such as ANOPP (Aircraft Noise Prediction Program)
  – Challenges
    • Source does not include impact of forward flight or installation effects
    • Measurements may be impacted by ground effects
    • May need to quantify of non-linear propagation effects
    • Need to understand azimuthal directivity for non-circular configurations

• Flight deck predictions
  – Quantify exposure of personnel on the flight deck
  – Challenges
    • Measurements may not include solid surface effects (jet blast deflector, flight deck)
    • Missing installation effects
    • Advanced nozzle configurations will likely have azimuthally varying sound fields
    • Near-field propagation techniques have not been developed for TACAIR exhausts so propagating measured near-field data to other near-field locations will be difficult
Use of Engine Stand Data for Military Noise Challenges

• Accurate Prediction and Quantification of Noise
  – Includes noise from “baseline” nozzle configurations and noise reduction devices
  – Challenges
    • Forward flight and installation effects can impact noise reduction
Use of Engine Stand Data for Military Noise Challenges
- Community Noise -

Forward Flight Corrections

Norum, Garber, Golub, Santa Maria (2004), NASA/TP-2004-212686

- Significant flight corrections dataset from F-15 Active Aircraft test
- Flight corrections may be very different for non-axisymmetric jets
- Need additional research to understand flight corrections for non-axisymmetric jets
Use of Engine Stand Data for Military Noise Challenges - Community and Flight Deck Noise -

**Azimuthal Variation**

- Advanced nozzle configurations have azimuthal and polar sound-field variations
- Scale-model data exists for quantifying variations in subsonic jets

*Bridges (2012), AIAA-2012-2252*
Use of Engine Stand Data for Military Noise Challenges - Community and Flight Deck Noise - *Installation Effects*

Bozak, Henderson (2011), AIAA-2011-2790

- Model scale data exists for round and rectangular twin jets
- How will multi-jet effects change for advanced configurations
Use of Engine Stand Data for Military Noise Challenges  
- Flight Deck Noise, Accurate Quantification of Noise -  

Measurement Location

• Subsonic noise reduction similar at 100D and 40D

• Supersonic noise reduction is different in mid and far field

Nimitz Flight Deck Width = 252’ ~ 126D
Assumes D = 2’

Subsonic Jet

Overexpanded Jet

Henderson, Bridges
Use of Engine Stand Data for Military Noise Challenges
- Accurate Prediction and Quantification of Noise -

**Noise Reduction and Forward Flight**

**Subsonic Jet Chevron Noise Reduction**

Nesbitt, Young (2008), AIAA-2008-3065

**Overexpanded Jet Chevron Noise Radiation**

Henderson, Bridges (2010), AIAA-2010-3926
Questions/Comments

• What types of measurements will be needed in the future
  – Will we need measurements in the extreme far-field or will additional fundamental research provide us with adequate propagation tools
  – What will be the azimuthal requirements for future engine architectures/nozzles and has this been considered in the development of the standard
  – Will we need to include additional realism such as JBDs as a requirement for flight-deck noise quantification
  – Can we learn enough about flight and relevant installation corrections that follow-on flight tests will not be needed

• Have we clearly defined the intent of the proposed standard
  – Where is the line between research type measurements and measurements that fall within the scope of the standard