Sonic Boom Modeling Technical Challenge

- Brenda M. Sullivan
- Fundamental Aeronautics 2007 Annual Meeting
- New Orleans, LA
- Oct 31, 2007
• Technical Challenge Overview

• Status & Highlights

• Future Work
Sonic Boom Modeling Technical Challenge

Develop knowledge, capabilities and technologies to enable overland supersonic flight

Sonic Boom Features

Conventional
- Multiple Shocks of Differing Strengths
- Shocks begin to Coalesce
- High Intensity "N-wave" at the Ground

Low Boom
- Shock Strength and Position Controlled
- Controlled Coalescence
- Low Intensity "Shaped" Boom at the Ground

NASA Program Elements

- Modeling of Flow Around Aircraft
- Modeling of Effects of Realistic Atmospheres
- Modeling of Response to Booms
Sonic Boom Modeling

Objectives

• Develop and validate sonic boom propagation model through realistic atmospheres, including effects of turbulence

• Develop methods enabling prediction of response of and acoustic transmission into structures impacted by sonic booms

• Develop and validate psychoacoustic model of human response to sonic booms under both indoor and outdoor listening conditions, using simulators

Technical Challenge Elements

• NRA contracts/cooperative agreements

• Atmospheric Propagation

• Structural Response and Modeling

• Human Response and Modeling
FY07 Highlights

• 2007 flight test for atmospheric propagation and structural response measurements completed
  – Significant contributions from Gulfstream, Penn State U., Purdue.
  – Visitors from FAA and other members of the FAA PARTNER Center Of Excellence

• Conceptual design for indoor sonic boom simulator completed
  – Risk reduction experiments being performed
  – Preliminary design in progress.

• 5 NRA Proposals funded
Topics:

- Modeling and analysis for atmospheric sound propagation
- Diffraction around individual and aggregated building structures
- Transmission of sonic booms into building structures (2 awards)
- Modeling of rattle and other contact induced noise
Modeling and Analysis for Atmospheric Sound Propagation

Objective:

Develop efficient and robust models to predict outdoor sonic boom exposure under realistic atmospheric conditions and for all flight conditions.

Award:

Atmospheric sonic boom prediction model (Wyle Labs)

Principal Investigator: Juliet Page

Two Year Program: 9/07 – 8/09

- Investigate near field prediction to far-field 3-D pressure field transition
- Improve propagation capability to more accurately predict boom shape
- Include turbulence modeling
Diffraction of Sonic Booms around Building Structures

Objective:

Predict pressure loads (temporal and spatial) on building

Award:

Low-boom sonic boom coupled diffraction around individual and aggregated building structures (Penn. State University)

Principal Investigator: Vic Sparrow
Two Year Program: 8/07 – 7/10

• Develop computer codes to quantify temporally and spatially dependent forces on buildings due to low booms
• Use NASA field test data to validate models for single dwellings
• Expand to multiple structure – “urban canyons”
Transmission of Sonic Booms into Building Structures

Objective:
Develop models to predict the structural acoustic response of building interiors due to exposure to sonic booms of arbitrary wave shape.

Awards:
Development of a model for predicting the transmission of sonic booms into buildings (Virginia Polytechnic Institute & State University)
Principal Investigator: Ricardo Burdisso
Two Year Program: 9/07 – 8/09

Transmission of sonic boom into building structures (Wyle Labs)
Principal Investigator: Natalia Sizov
Two Year Program: 9/07 – 8/09
Modeling of Rattle and Other Contact Induced Noise

Objective:

Develop models to predict interior noise levels from window rattle and other contact induced acoustic sources subjected to sonic boom excitation

Award:

Modeling of rattle and other contact induced noise (Wyle Labs).

Principal Investigator: Natalia Sizov

Two Year Program: 9/07 – 8/09

- Measure window rattle in situ
- Study selected windows under controlled conditions in laboratory tests
- Develop and validate model
• Atmospheric Propagation
• Structural Response and Modeling
• Human Response and Modeling
Atmospheric Propagation

Propagations data acquired in conjunction with structural response field test

- 17 low-intensity and 10 conventional sonic booms recorded by sailplane at altitude
- Recordings above the Planetary Boundary Layer to be compared to recordings of same booms on ground
- 35-ft tower populated with microphones to investigate terrain and atmosphere effects
July 2007 structural response / transmission field test completed
Human Response and Modeling

Preliminary design of interior simulator for human response to sonic boom
Future Work

Plans for FY2008

- Continuing work with NRA award recipients
- Complete design and construction of indoor sonic boom simulator
- Develop high frequency structural acoustic transmission models
- Design Over-the-Top sonic boom flight test

over-the-top sonic boom