Environment Goals:
Emissions and Noise
Aeronautics & Space Transportation Technology: Three Pillars for Success

3rd Workshop on NASA’s Environmental Compatibility Research
Monterey, CA
July 7, 1998

Howard L. Wesoky
Team Leader
Environmental Compatibility Assessment
Charter: The Environmental Compatibility Assessment (ECoA) Core Team has been directed by the Executive Board of the NASA Office of Aeronautics & Space Transportation Technology to assess the ability of current programs to achieve the “Three Pillar” Emissions and Noise goals and to recommend what additional effort may be required.

Vision: In collaboration with carriers, manufacturers, academia, other government agencies and NGO’s, NASA will develop robust technology options with the objective that environmental issues do not constrain the growth of air transportation.
Environmental Compatibility Assessment Core Team Members

Office of Aeronautics & Space Transportation Technology: Howard Wesoky, Team Leader

Ames Research Center: Chuck Smith, Paul Soderman

Dryden Flight Research Center: Ron Ray

Langley Research Center: Doug Dwoyer, Dave Stephens

Lewis Research Center: Carol Russo, John Rohde

Assisted by HQ Support Contractor: SAIC
ASTTAC Task Force on NASA’s Aviation Environmental Compatibility Research: Charter

1. Based on examining past application of NASA research, recommend ways to improve effectiveness of environmental technology transfer.
2. Evaluate process being used to assess and recommend NASA research plans in noise and emissions relative to the “Three Pillars” environmental goals.
3. Recommend ways to ensure the appropriate use of research in regulatory considerations.
4. Recommend ways of improving the relationship of NASA with the air carrier community, aircraft and engine manufacturers, other environmental research and technology organizations, and regulatory agencies with regard to environmental research and technology.
5. Identify critical interdependencies of environmental goals with the other related “Three Pillar” goals.

Final report due August 31, 1998
ASTTAC Task Force on NASA’s Aviation Environmental Compatibility Research: Members

- Mike Benzakein, GE, Chairperson
- Tom Auxier, P&W
- John Begin, Northwest Airlines
- Bob Cuthbertson, Boeing Commercial Airplanes
- Julie Ellis, FedEx
- James Erickson, FAA
- Wes Harris, MIT
- Ram Janakiram, Boeing Helicopter
- Max Malone, United Air Lines
- Bill Schultz, Gen Aviation Manufacturers Association
- Paul Stolpman, EPA

- Howard Wesoky, NASA, Exec Secretary
- Darlene Boykins, NASA, Administrative Assistant
White House Policy

• Maintain superiority of US aircraft and engines
• Improve safety, efficiency, and cost effectiveness of global air transportation system
• Ensure long-term environmental compatibility of aviation system

“Past research investments in technologies to reduce engine noise and emissions are paying dividends today. But more needs to be done. Environmental issues are likely to impose the fundamental limitation on air transportation growth in the 21st century.”

National Science & Technology Council, August 1995
European Commission
AERONAUTICAL RESEARCH
A coordinated approach to the aircraft of the next generation

Integrated design
Aerodynamic Efficiency
Engine emissions
Human factors
Cabin Environment
Concurrent Engineering
Intelligent manufacturing
Propulsion efficiency
Noise
External hazards
On-board systems
Maintenance
Competitive design & manufacture
Improved aircraft efficiency
Environmentally friendly aircraft
Aircraft safety & reliability
Passenger friendly aircraft
Passenger Services
Structural efficiency
NEXT GENERATION AIRCRAFT
“The public will continue to demand reductions in environmental damage and reductions of acoustic noise over urban areas. This will require the United States to collaborate with other nations to develop technology that will reduce or eliminate harmful aircraft engine emissions and technology that will enable quieter engines and operations, including revolutionary means to mitigate sonic boom effects over populated areas.”

Aeronautics & Space Transportation Technology: Three Pillars for Success

• “We believe there are technological solutions that will significantly reduce aircraft emissions that contribute to global warming and ozone depletion, even as travel volume increases.”

• “Can we go further and create aircraft that are so quiet that the predominant noise at airports comes from cars and buses?”
“Throughout the pillars we present ‘technology goals’ which are framed in terms of a final outcome, the anticipated benefit of NASA-developed technology, once it has been incorporated by industry.”

**Enabling Technology Goals**

- “Reduce emissions of future aircraft by a factor of three within 10 years, and by a factor of five within 20 years.”
- “Reduce the perceived noise levels of future aircraft by a factor of two from today’s subsonic aircraft within 10 years, and by a factor of four within 20 years.”

“Both of these environmental goals have the requirement to be achieved without affecting safety or affordability.”
Emissions Mandate

**KYOTO Challenge to Aviation (Dec 11, 1997)**

Kyoto Protocol Article 2, paragraph 2:

“The Parties included in Annex 1 shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal protocol from aviation ..., working through the International Civil Aviation Organization...”

**President Clinton’s Climate Change Proposal (Global Climate Change Policies -- October 22, 1997)**

**ICAO Actions on LTO Emissions**

Standard for Gaseous Emissions

- unburned hydrocarbons
- smoke
- carbon monoxide
- oxides of nitrogen

CAEP 2 - NOx Reduction of 20%; effective 1996
CAEP 4 (April 1998) - Further NOx reduction of 16%

**Montreal Protocol, 1987**

Greenhouse gases

- Carbon dioxide
- Methane
- Nitrous oxide
- Hydrofluorocarbons
- Perfluorocarbons
- Sulphur hexafluoride

**Global Warming Reversal**

**Improved Local Air Quality**

**Ozone Depletion Recovery**

*NASA Needs to Take the Leadership in Providing Aircraft Emissions Reduction Technologies to Enable Continual Growth in Air Transportation*
Aviation and the Kyoto Protocol

Effect of Proposed Environmental CO₂ Goals

- No Improvement Beyond 1997 Technology
- 25% Reduction Introduced in 2007
- 50% Reduction Introduced in 2022
- Zero CO₂ Emission A/C Introduced in 2027
- Zero CO₂ Emission A/C Introduced in 2037

( - GA and Military Emissions based on Boeing forecast
  - IPCC IS92a based ICAO demand model
  - No retrofit of technologies)

Change Relative to 1990:
- +340%
- +230%
- +140%
- +40%
- -20%

Effectiveness of Advanced Technology In Reducing Total CO₂ Emitted From Aircraft
Noise Mandate

- Meet international regulations (increased stringency) and local rules
- Maintain and improve competitiveness of air transportation

Growing Noise Constraints on Air Travel

NASA Needs to Take the Leadership in Providing Aircraft Noise Reduction Technologies to Enable Continual Growth in Air Transportation
Aircraft Noise Reduction And Community Impact

Single event aircraft noise reduction, EPNL

Impact

Growth range

Current

Technology

AST

3 Pillar

No intrusion

Year

Noise impact at airport boundary, DNL

1990 2000 2010 2020 2030 2040

+10 0 -10 -20 -15 -10 -5 0 +5 +10

75 65 55

Environmental Compatibility Assessment
1. What are the impacts of aviation noise and emissions on the environment?

2. How do you believe those impacts may affect the growth of aviation?

3. Must the growth of aviation lead to increased environmental impact?

4. What is the relationship of NASA’s noise and emissions goals to aviation’s impact on the environment?
Workshop Objectives

Workshop #1: Shared learning, coalition building with a large, wide group of participants.

- What are the environmental issues that are likely to impose fundamental limitations on aviation’s growth?
- What are the technical challenges faced in eliminating the fundamental limitations to aviation’s growth?

Workshop #2: Review customer needs and benefits, develop roadmaps.

- Review scenarios
- First cut gap analysis
- Strawperson roadmaps
- Customer benefits

Workshop #3: Suggest research and technology areas, refine roadmaps, and chart way forward.

- Review roadmaps
- Priorities - What needs to be started now?
- Fostering creativity
- The way forward

"Customer" problems and issues, clarification of "benefits."

Clear program options!
Workshops

I. Atlanta, GA  March 17-19
II. Cleveland, OH  May 19-21
III. Monterey, CA  July 7-9
Workshop I & II Attendees

- NASA HQ, ARC, DFRC, GSFC, LaRC, LeRC
- Other govt: DoD, EPA, FAA, OSTP, White House Climate Change Task Force
- Universities: Georgia Tech, U of Maryland, MIT
- Industry associations: AIA, ATA, GAMA
- Air carriers: Delta Air Lines, United Air Lines
- Airports: Dallas-Fort Worth, San Jose, LAX, PONY/NJ, Nashville, SeaTac
- NGO’s: Center for Clean Air Policy, Environmental Defense Fund, National Organization to Insure Sound Environment, Natural Resources Defense Council
- Others: Aerodyne Research, HMMH, Transportation Solutions, GRA, Wyle Labs, Mitre, Cutler & Stanfield, Landrum & Brown, McDermott, Will, & Emery, Camp Dresser & McKee Inc
Summary

• Strong mandate for NASA to initiate significant investment towards “Three Pillars” emissions and noise goals

National Aeronautics and Space Act of 1958: The aeronautical and space activities of the United States shall be conducted so as to contribute materially to . . . The expansion of human knowledge of phenomena in the atmosphere . . . The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles . . . The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere.