SPECIAL FACTORS

HSCT IMPACT ON OUTSIDE WORLD
AIR TRAFFIC CONTROL
## Current and Planned ATC Systems

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<th>CURRENT</th>
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Enroute Environment

Communication/Navigation/Surveillance

LEGEND
CS = Communication Satellite
GPS = Global Positioning System
COM = Communications
SURV = Surveillance
NAV = Navigation
ADS = Automatic Dependent Surveillance
DL = Data Link
Air Traffic Control
Study Conclusions

- Foresee No Significant Hardware Problems for Year 2000/2015 Airplanes -
  - Current NAS plans will provide:
    - Worldwide navigation and communication coverage
    - Automatic data linking
    - Strategic control
    - Curvilinear approaches

- Problems Foreseen: Domestic and International Procedures and Standards
  - Control and efficient use of airspace
  - Transition operations
  - Impact of HSCT airplanes on airport capacity
AIR PORTS
• Potential HSCT airports were designed/built in 1960’s and 1970’s and are approaching full capacity today.
  • Traffic will double by year 2000 - double again by 2015.

• Conclusion: as long as we need to design/build new terminals, runways, etc. anyway - might as well plan for HSCT.

• HSCT will require:
  • New jetways
  • Electronic steering guidance
  • Strengthened runways
  • Unconventionally fueled HSCT’s will require new fuel storage and distribution systems
COMMUNITY NOISE IMPACT
MIRROR IMAGE NOISE CONTOURS
85 dBA

- M2.4
  3.91 Sq. Mi.

- M4.5
  4.76 Sq. Mi.

- 12,000 Ft. RUNWAY

- 747-300
  6.4 Sq. Mi.

1 MILE
85 dBA Noise Footprint

Heathrow, London

HEATHROW (LON)
85 dBA Noise Footprint

Heathrow, London
Noise Study Conclusions

Community Noise Impact:

- Preliminary conclusions:
  - Up to M 4.0 airplane:
    - Noise footprint potentially smaller than Stage 3 subsonics (wider, but shorter)
    - Impact on community can be less than subsonics (more footprint within airport boundary)
    - But could not meet today’s FAR 36 for subsonics without major penalties
  
- Above M 4.0 airplane
  - More engine/configuration study required
Noise Study Conclusions (continued)

Interior Noise Impact

- All of today's subsonic jetliners have about the same cabin noise levels:
  - These noise levels should be criteria for HSCT

- M2.4 SST meets these criteria
  - Minor high frequency noise problem

- Analysis of boundary layer noise at higher Mach numbers shows reduced exterior noise

- Conclusions:
  - Near term airplane:
    - Minor special attenuation techniques for boundary layer caused noise
    - Engine noise - ?
  - 2015 airplane
    - No boundary layer noise problems
    - Sonic fatigue, engine noise - ?
SONIC BOOMS
SCHEMATIC OF GROUND EXPOSURE CARPETS AND SONIC BOOM WAVEFORM CHARACTERISTICS
Sonic Boom Study “Conclusions”

- Reviewed 728 sources generated since last survey (1973)
- Concluded that we can more accurately predict how sonic booms would be:
  - Generated
  - Propagated
  - Focused and aimed
  - Minimized
- The key issue that still isn’t understood is:
  - How will humans respond to given overpressure levels and waveforms?
- Proposing major study to define acceptable criteria
  - Mostly in lab to verify:
    - Evidence that there is a “startle threshold” below which sonic booms may be acceptable. (0.6 to 0.8 PSF for N-wave)
    - Evidence that by tailoring the waveform, the maximum overpressure can be significantly higher
    - That such tailoring is achievable for practical airplane design/operation.
SONIC BOOM WAVEFORMS JUDGED EQUALLY LOUD

$\Delta P_{\text{MAX}}$ - MAXIMUM OVERPRESSURE
$\Delta P_{\text{SH}}$ - FRONT SHOCK OVERPRESSURE

N-WAVE

LOW BOOM

$\Delta P_{\text{SH}} = 0.500 \text{ psf}$

$\Delta P_{\text{SH}} = 0.3342 \text{ psf}$
HIGH ALTITUDE ATMOSPHERICS
Atmospheric Profiles

OZONE
Mid-Latitude Model

Cosmic Radiation
Mid-Latitude Model

Aerosol Particles
(Hawaii 30 Dec. 1985)
Volcano Ruiz

Height (k ft.)

Concentration (mg./M3)

Dose Rate (Rems/Yr)

Number Density (N/cm3)

Cruise Altitude

M = 10.0

M = 2.4

HSCT-51
4-87
Assessment of HSCT Fleet Impact on Ozone

- HSCT Fuel Options
- HSCT Fleet Size/Operations
- HSCT Route Structure
- Atmospheric Photochemistry
- Ozone Climatology
- Dynamic Weather Processes

Computer Model

Dynamic Processes and Climate Change
High Altitude Atmospherics study
Conclusions

- Environment impact on HSCT/passengers
  - Ozone = Catalytic converters
  - Radiation = Below EPA level
  - Aerosols = Operations issue

- HSCT impact on environment - Ozone
  - Evidence that the higher the altitude- the worse the impact
  - Conclusions not clear - modeling incomplete

- Action: Program required to assess HSCT fleet impact
FUELS
Conventional fuels with improved thermal stability can be supplied by existing refineries. However, there will be a price penalty.
REVISE CURRENT JET A SPECIFICATION FOR HIGHER THERMAL STABILITY — FUEL AVAILABLE FROM EXISTING UNMODIFIED JET FUEL POOL.

USE THERMAL STABILITY IMPROVING ADDITIVES IN SELECTED REFINERY CUT (ADD REFORMER RAFFINATE) — CONTROL DISTRIBUTION TO ELIMINATE CONTAMINANTS.

ADD REFINERY EQUIPMENT TO TAILOR FUEL PROPERTIES AND/OR CHANGE JET FUEL SPECIFICATION REQUIREMENTS, SUCH AS FLASH POINT, BOILING RANGE......
HEAT FROM AIRCRAFT TO STORED FUEL

HEAT FROM AIRCRAFT ABSORBED BY REACTION

HEAT FROM AIRCRAFT TO REACTION PRODUCTS

ENDOTHERMIC FUEL

HEAT EXCHANGER

CATALYTIC REACTOR

HEAT EXCHANGER
Even the simplest endothermic fuel reaction will be difficult to control and will have undesirable side reaction products, such as carbon.
Unconventional Fuels Study Conclusions

CONVENTIONAL FUELS

- JP can be Tailored to Provide Greater Thermal Stability (Δ up to 150° F.) - at a Moderate Price (0 ≤ Δ φ ≤ 48¢)

ENDOTHERMIC FUELS

- Have Not Found a Suitable Endothermic Fuel
- All have undesirable side reaction products (carbon deposits, changes to exothermic)

CRYOGENIC FUELS

- Methane’s “Cost” will be from Slightly Above to 6 Times Above Jet A’s “Price”
- Hydrogen “Cost” will be From 3 to 10 Times More Than Jet A’s “Price”
- Above “Costs” are for Delivery at Airport Boundary
- Additional expenses for storage tanks and dedicated fuel distribution system = $150 M - $800 M per airport
- Price = Cost + Profit Margin = ?
Even the simplest endothermic fuel reaction will be difficult to control and will have undesirable side reaction products, such as carbon.
Cost and Supply of Cryogenic Fuels

Major Effort Required to Satisfy Potential Fuel Needs
Cryogenic Fuel Distribution and Storage System
Unconventional Fuels Study Conclusions

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