



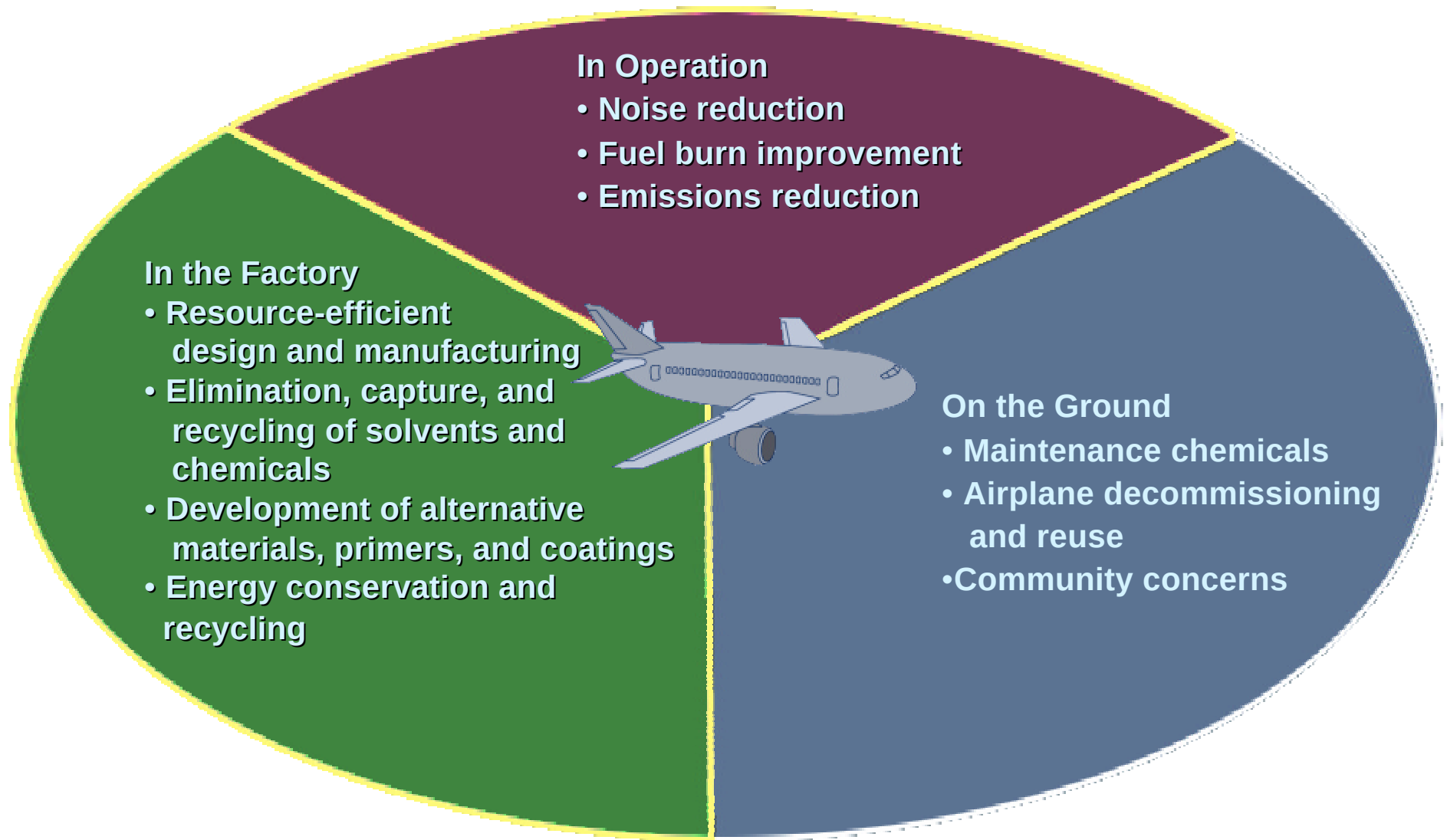
Commercial Aviation -Noise and Emissions Developments-

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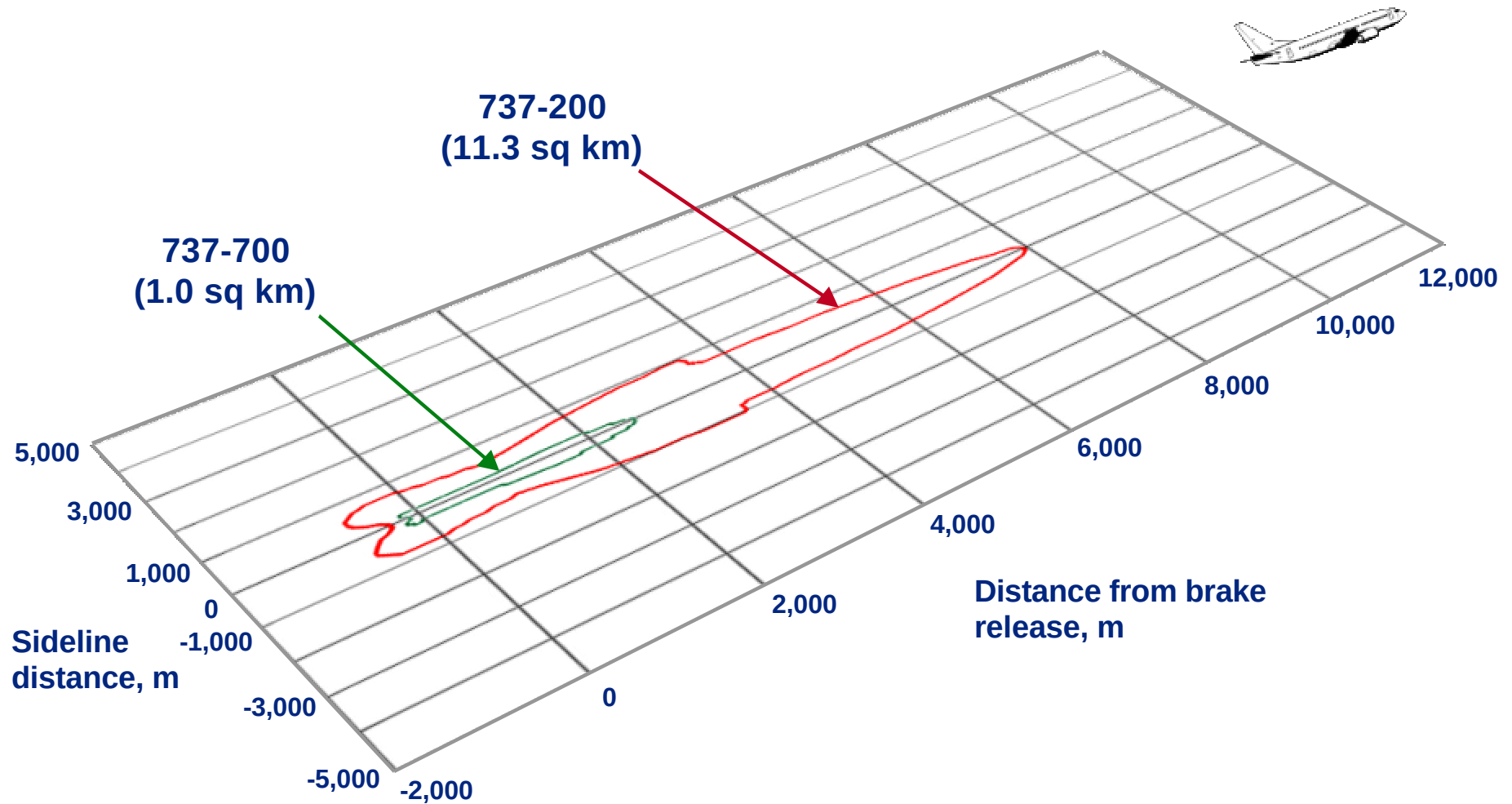
Environmental Challenges



Airplane Design is Always a Balance Among Various Objectives



Today's Airplanes are Quieter



85 dBA contours

Noise Improvement

Nacelle Improvement Example

777 engine – PW4084
(42.3 ft² effective lining area)



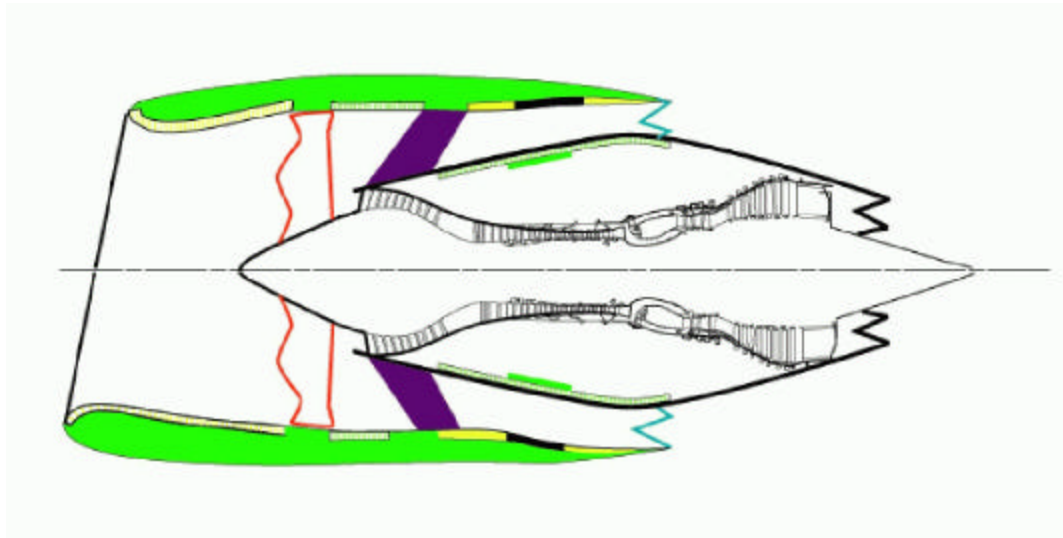
777-300 engine – PW4098
(67.6 ft² effective lining area)



Engine and Nacelle Noise Improvements

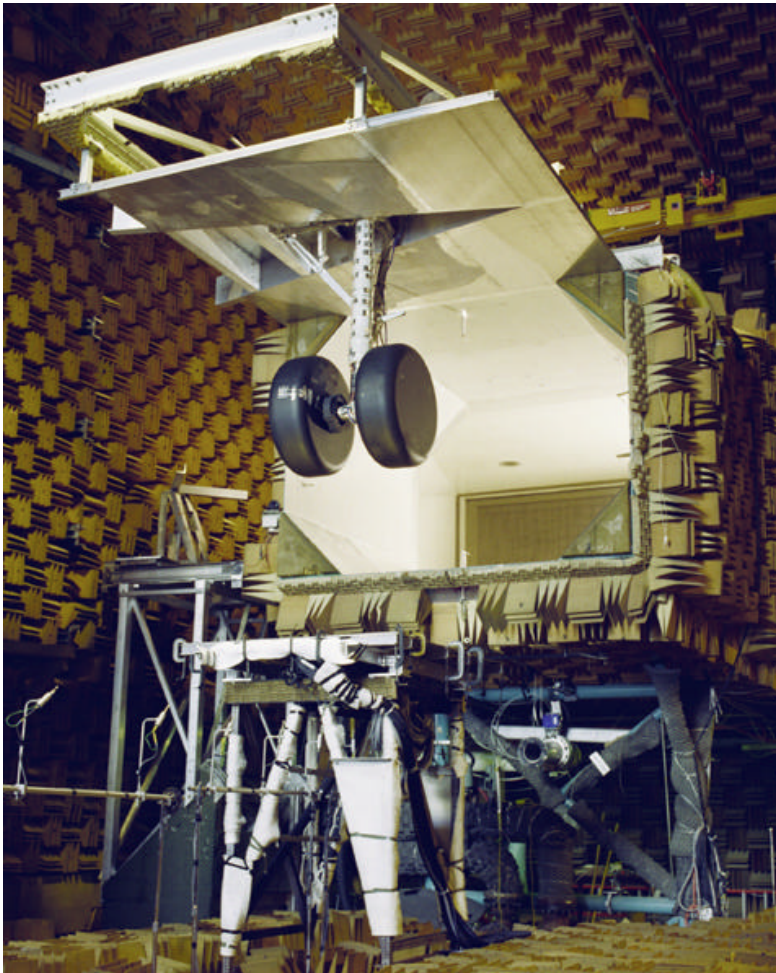
Possibilities

- Optimum bypass ratio
- Advanced fan blade design
- Low noise fan exit guide vane design
- Jet noise suppressor chevrons/tabs
- Stator and inlet boundary layer control
- Improved Materials
- Scarf inlet
- Maximum acoustic area
- Lining designs optimized at each location for maximum impact
- Active noise control
- Treated inlet lip
- Mode scattering linings fan duct



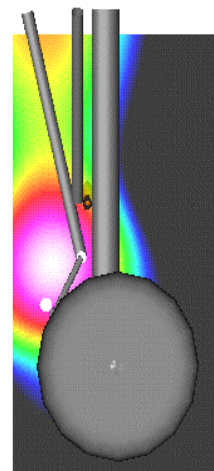
Airframe Noise Improvement

Landing Gear Example



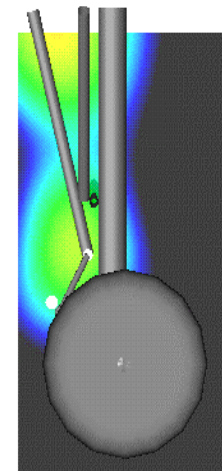
Wind tunnel testing indicates 2-3 dB reduction in Landing Gear Noise possible.

Fully Dressed Configuration



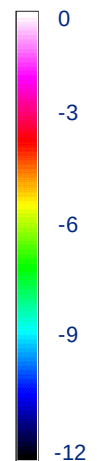
1000 Hz

Clean Configuration



1000 Hz

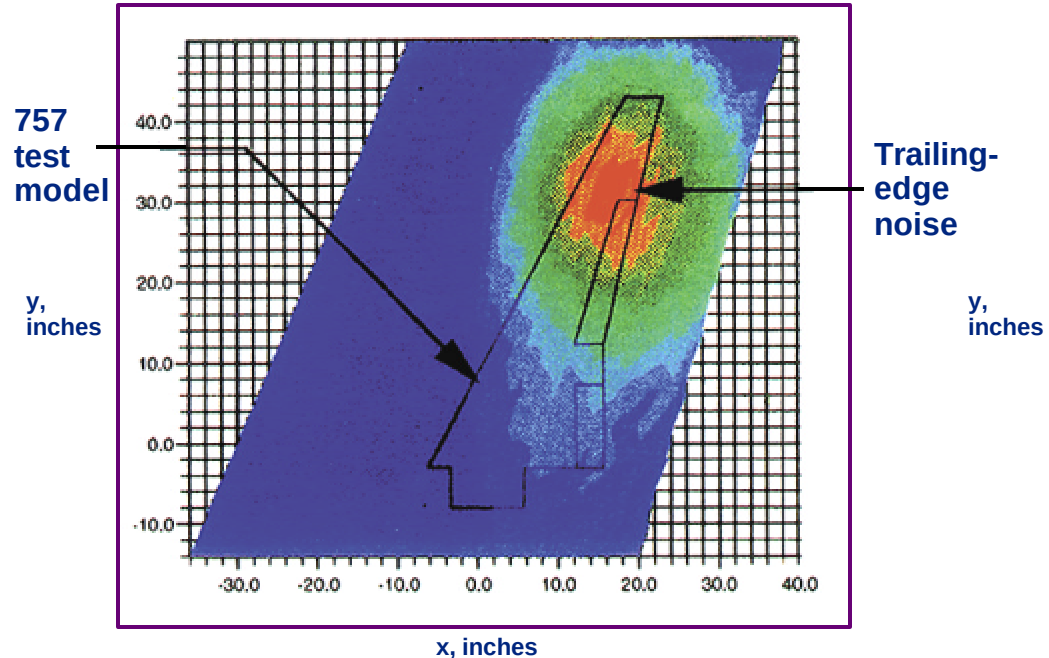
dB from Ref.



Airframe Noise Reduction

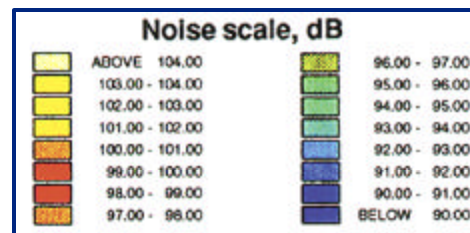
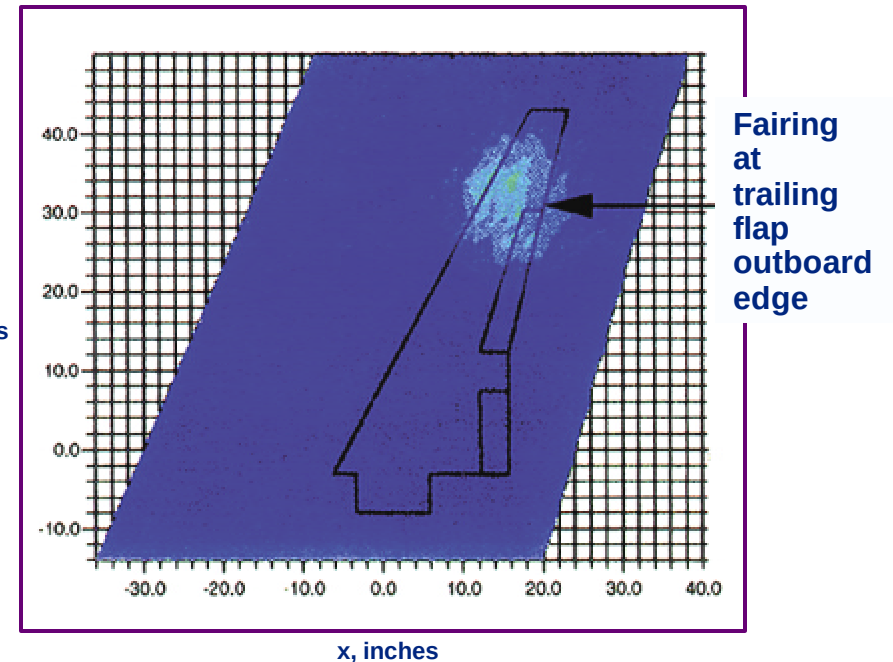
Baseline configuration

High-frequency 31,500 Hz



Low-noise airframe configuration

High-frequency 31,500 Hz



Airframe Noise Improvements

Possibilities

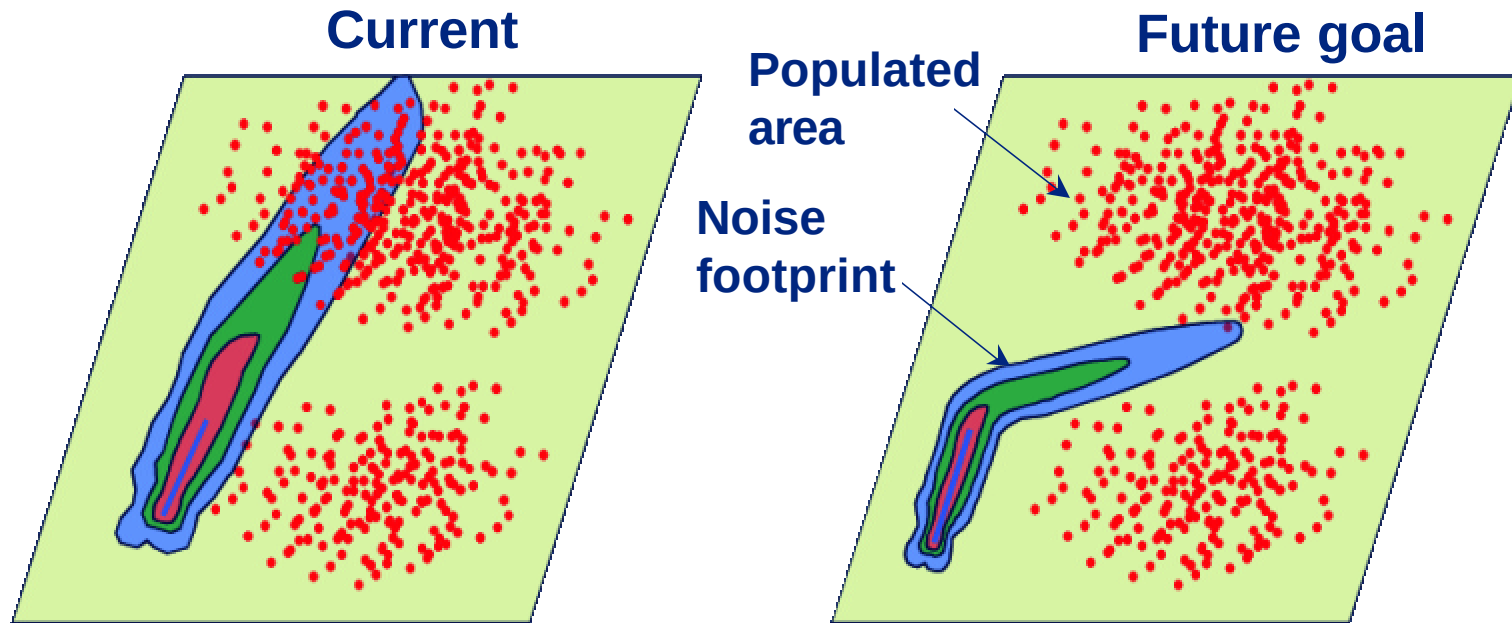
- Low noise landing gear design
 - Active flow control
- Low noise slat and flap designs
- Low Speed - Drooped ailerons for T/O & landing
 - Low Speed - Active flow control



Noise Improvements

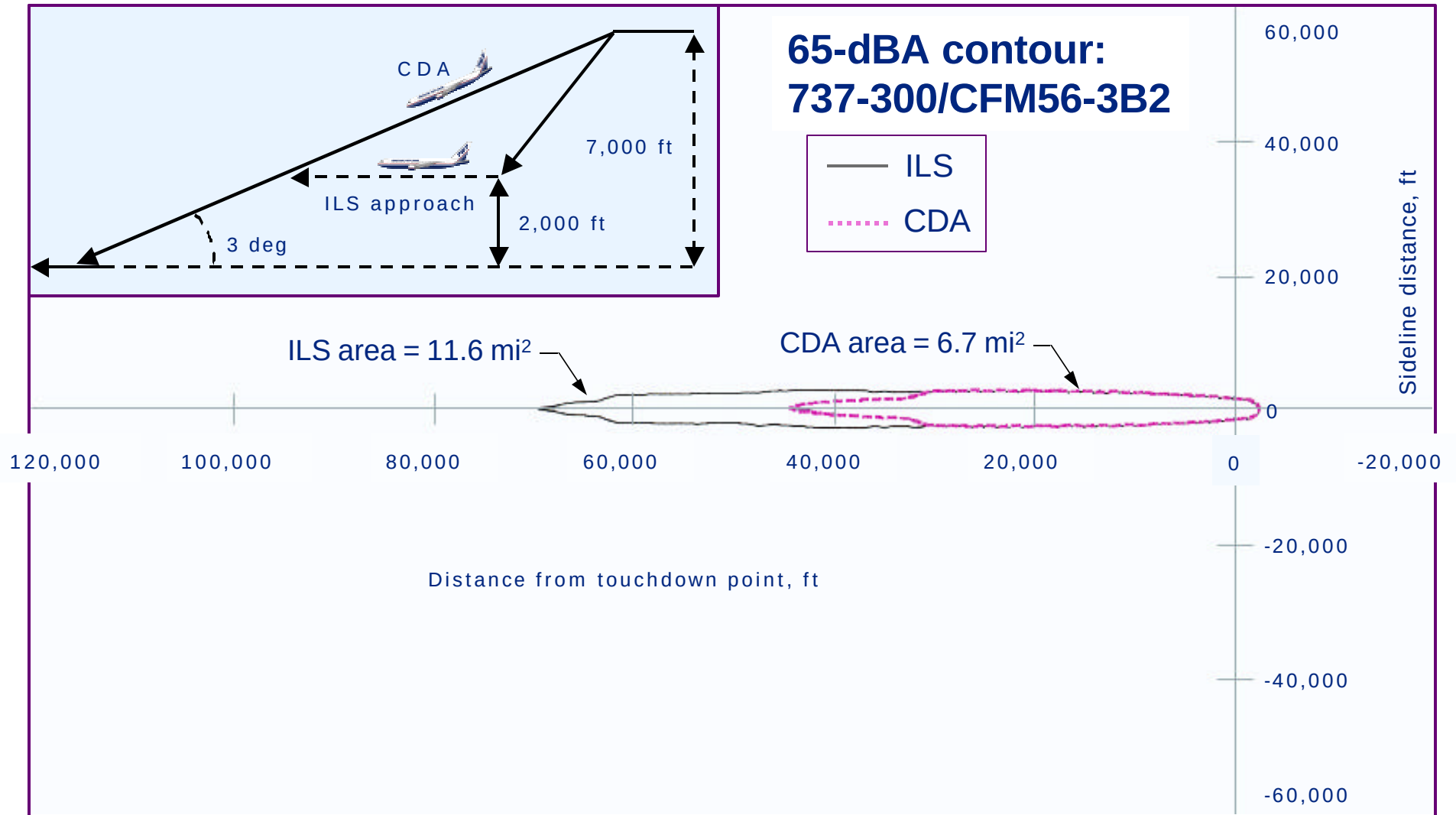
Flight Procedures

Flight Operating Procedures for Low Community Noise

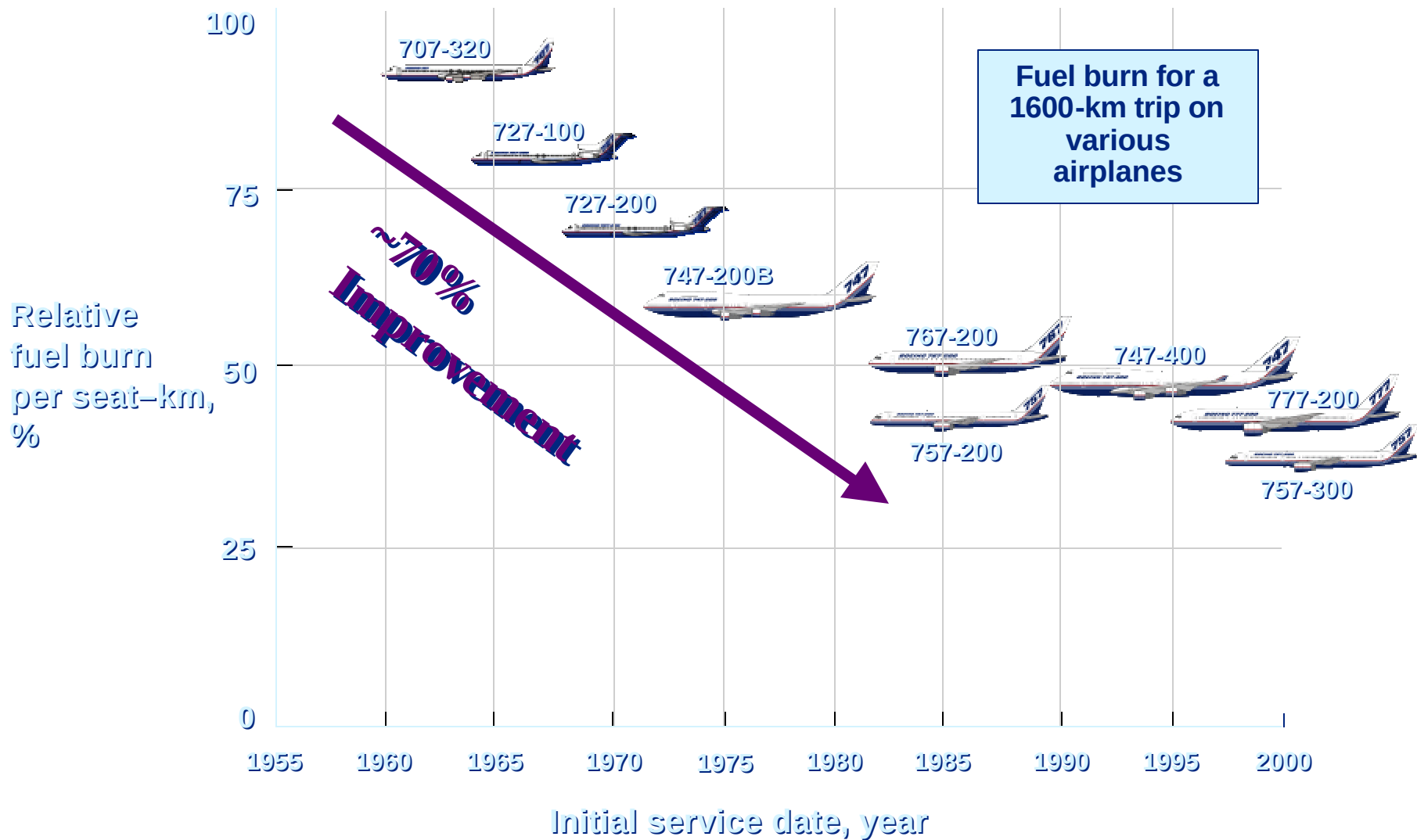


- Technology improvements
- Advanced air traffic procedures
- Modern avionics
- Land-use planning

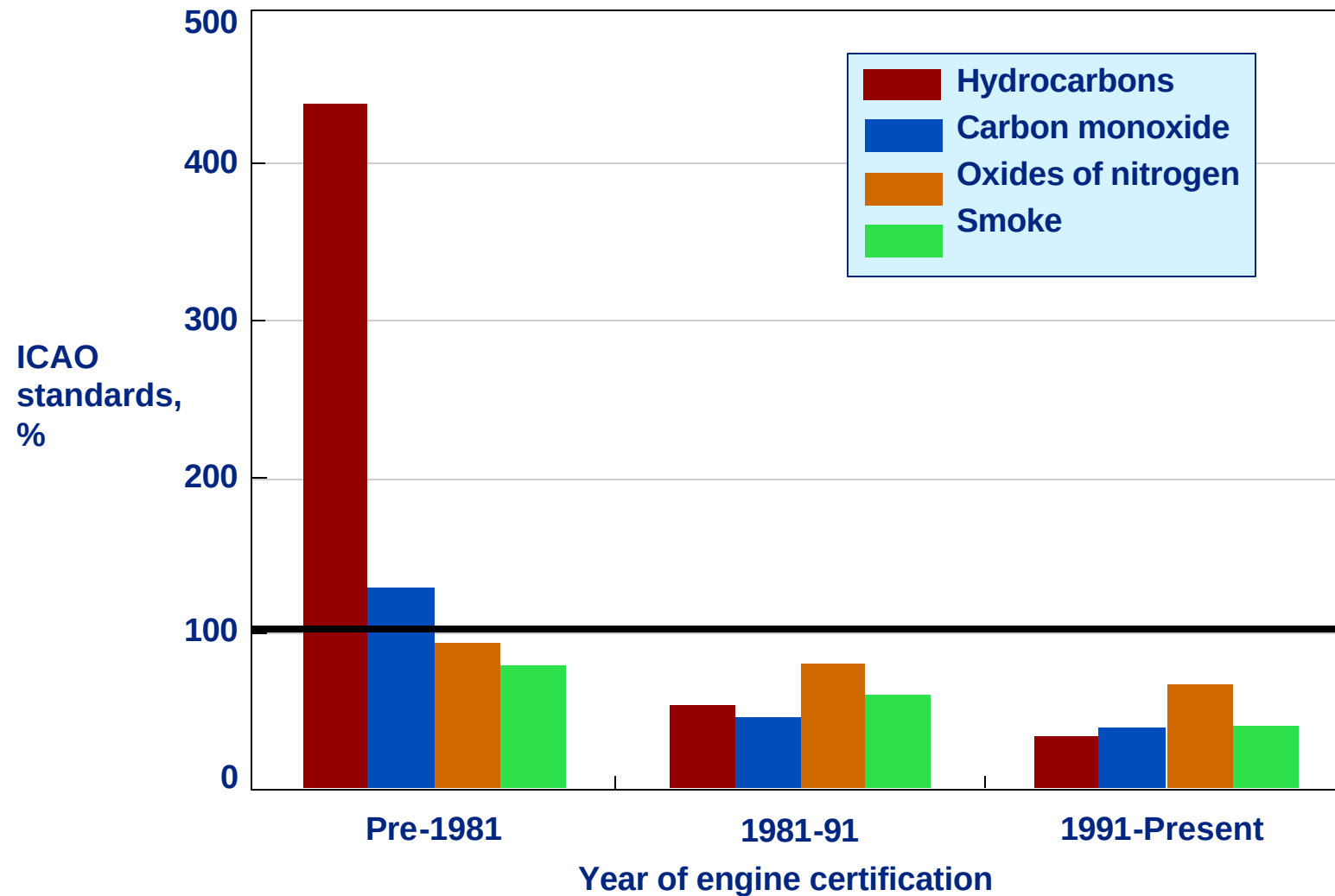
Airplane Approach Procedures Can Reduce Noise



Today's Airplanes Burn Less Fuel



...and Produce Fewer Emissions



Ongoing Research and Development

Boeing Winglet Program

Winglet benefits:

Reduced fuel burn

Reduced noise

Reduced emissions



737- 800 With Optional Winglets* Potential Performance Benefits

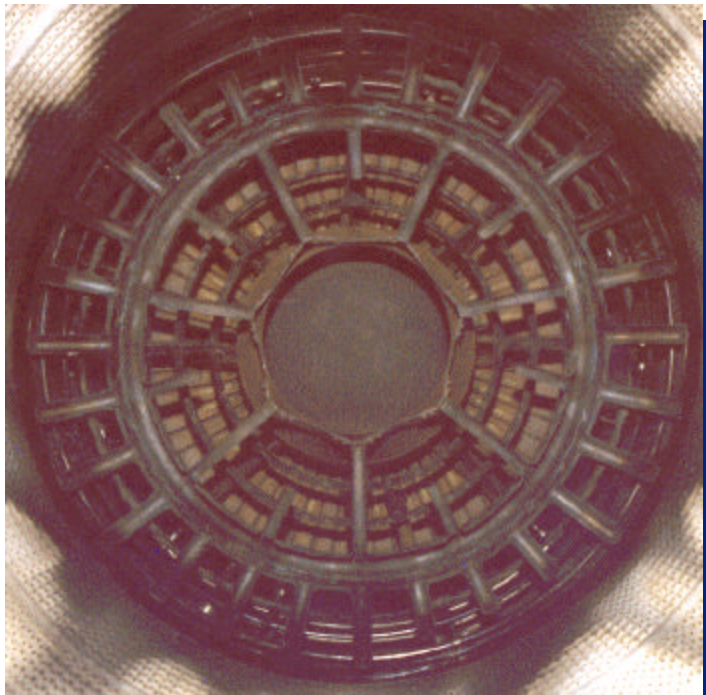


- Design range: +125 nmi
- Fuel burn:
 - 2.6% for 500- nmi mission
 - 3.6% for 1,000- nmi mission
- Payload at fixed range:
 - +6,000 lb at fuel capacity limit
 - +1,000 lb at maximum takeoff weight limit
- Takeoff noise:
 - 0.5 to -0.7 EPNdB at cutback(Sea level, 30 ° C, 7,000- ft field length)

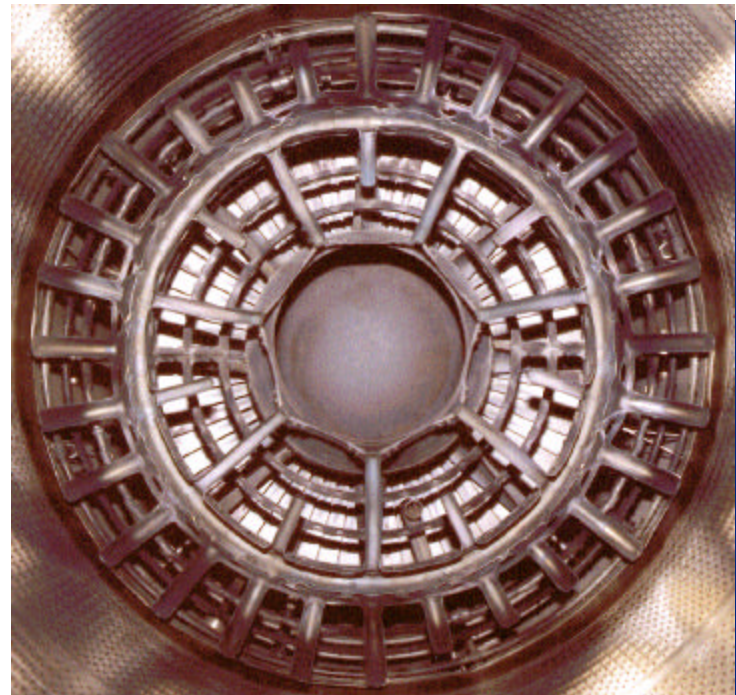
* 737- 800 winglets available spring 2001

Alternate Fuel Research May Reduce Engine Emissions

Normal exhaust appearance



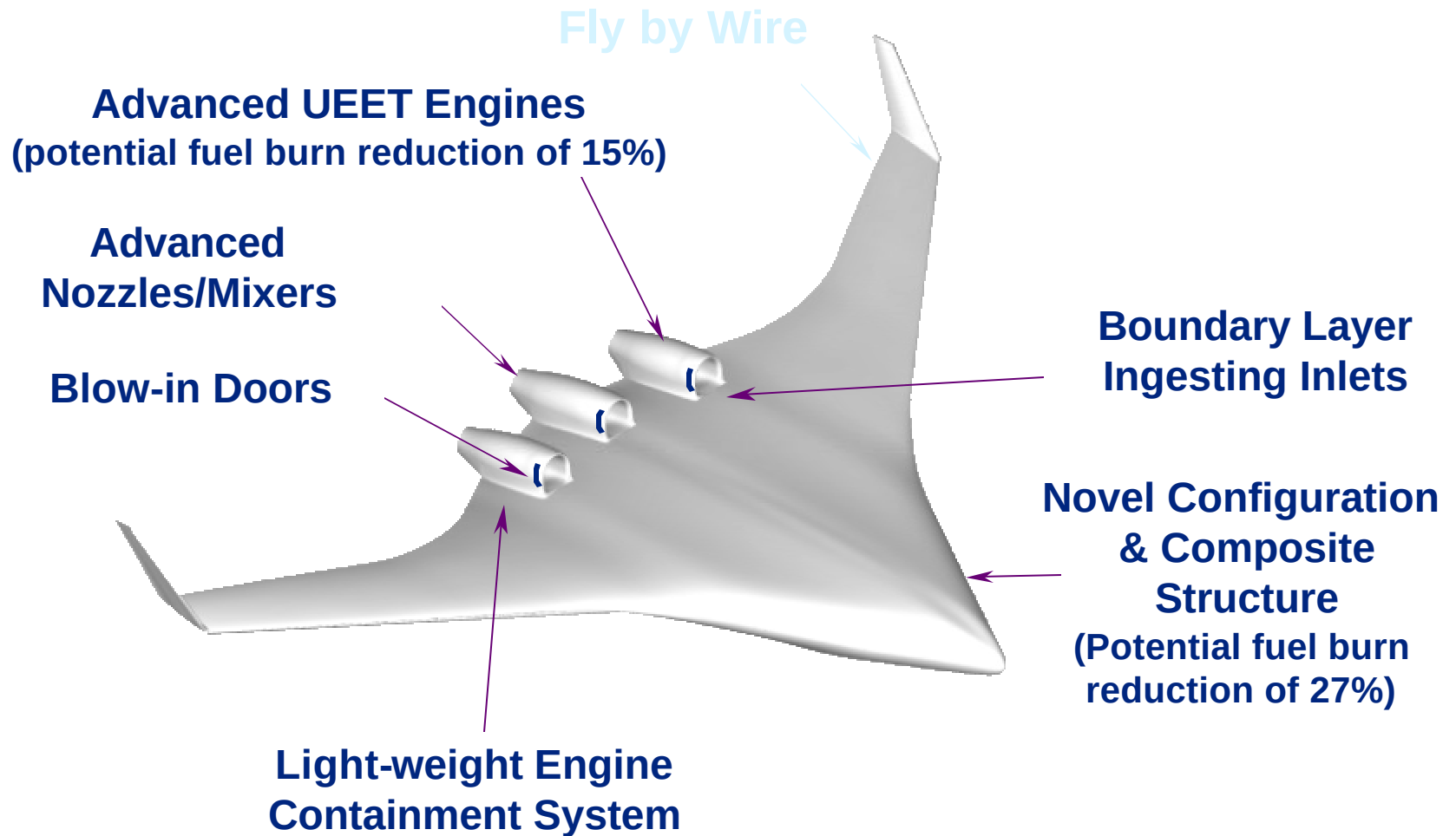
Appearance after JP-8 +100 use



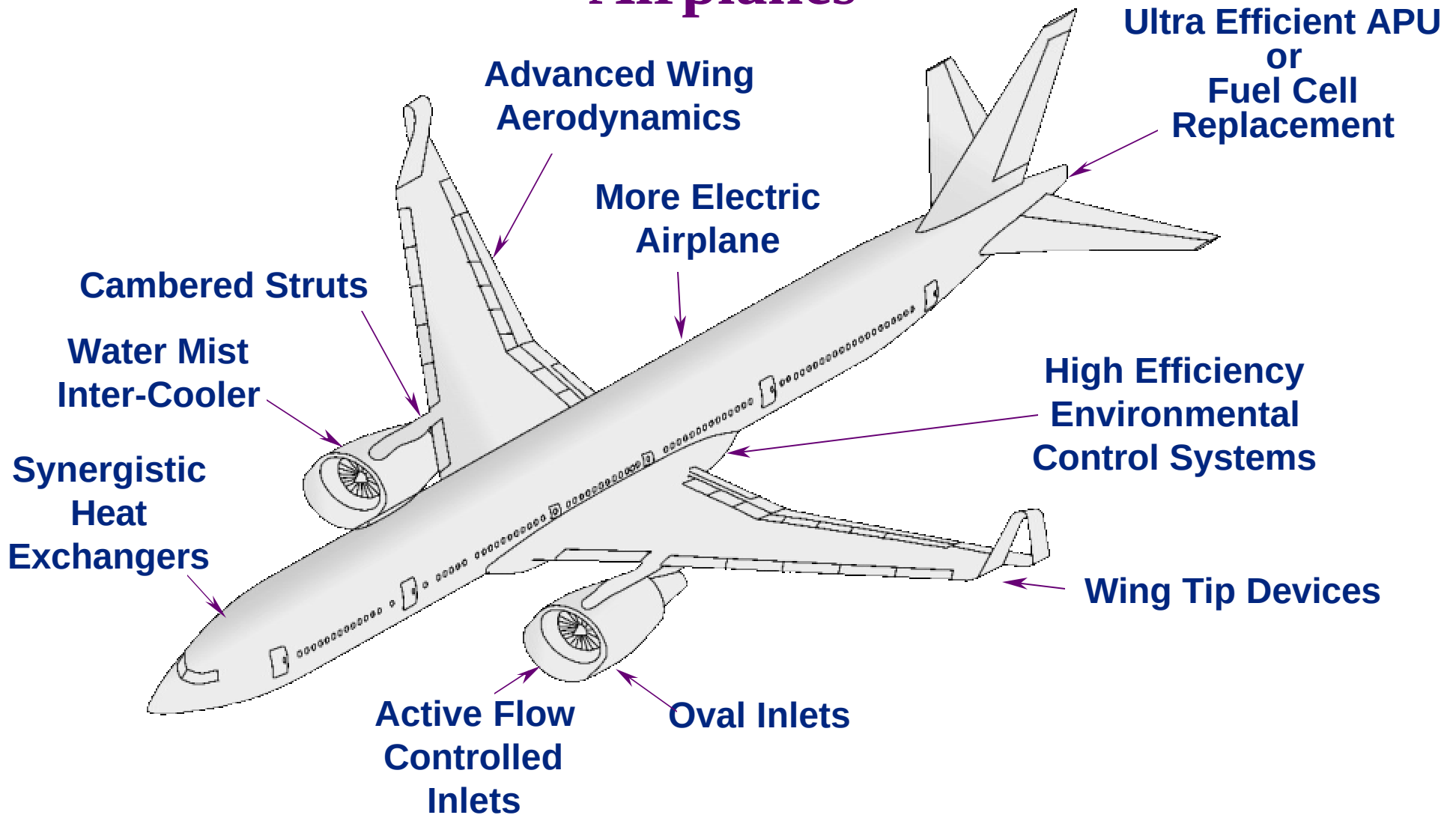
+100
Additive

*Evaluating the
potential for
emissions
reduction*

Boeing is Always Exploring New Possibilities



Additional New Technologies can Further Reduce Fuel Consumption on Conventional Airplanes



Summary

- **Boeing cares about the environmental impact of our products - in the air, on the ground, and in production**
- **Excellent progress has been made on noise and emissions.**
- **We are committed to further improvements.**
- **Our goal is safe, efficient, affordable airplanes with excellent environmental performance.**