Measures to Reduce Airport-Related Pollution

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OTC Airport Workshop
December 5, 2001

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Presentation Overview

- Aircraft Measures
- Ground Support Equipment Measures
- Ground Access Vehicle Measures
- Improving Inter-city Rail Service
- Conclusions

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Aircraft technical options

- Since 1968 intensity of aircraft energy use has fallen 60% due to enhanced engine efficiency, improved aerodynamic performance and load factor
- NASA's clean engine program has a goal of reducing aircraft engine emissions 60%
- Opportunities for future energy savings and emissions reductions are significant

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Aircraft Technical Measures*

- Dual annular combustors
- Increased by-pass air ratio
- Introduction of turbofan engines
- Composite aircraft bodies
- Blended and/or hybrid laminar flow control wing flying configuration
- Fuel options - hydrogen in the future

* recommendations drawn from “Greener by Design”

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Blended Wing Body Configuration

Source: Air Travel: Greener by Design The Technology Challenge

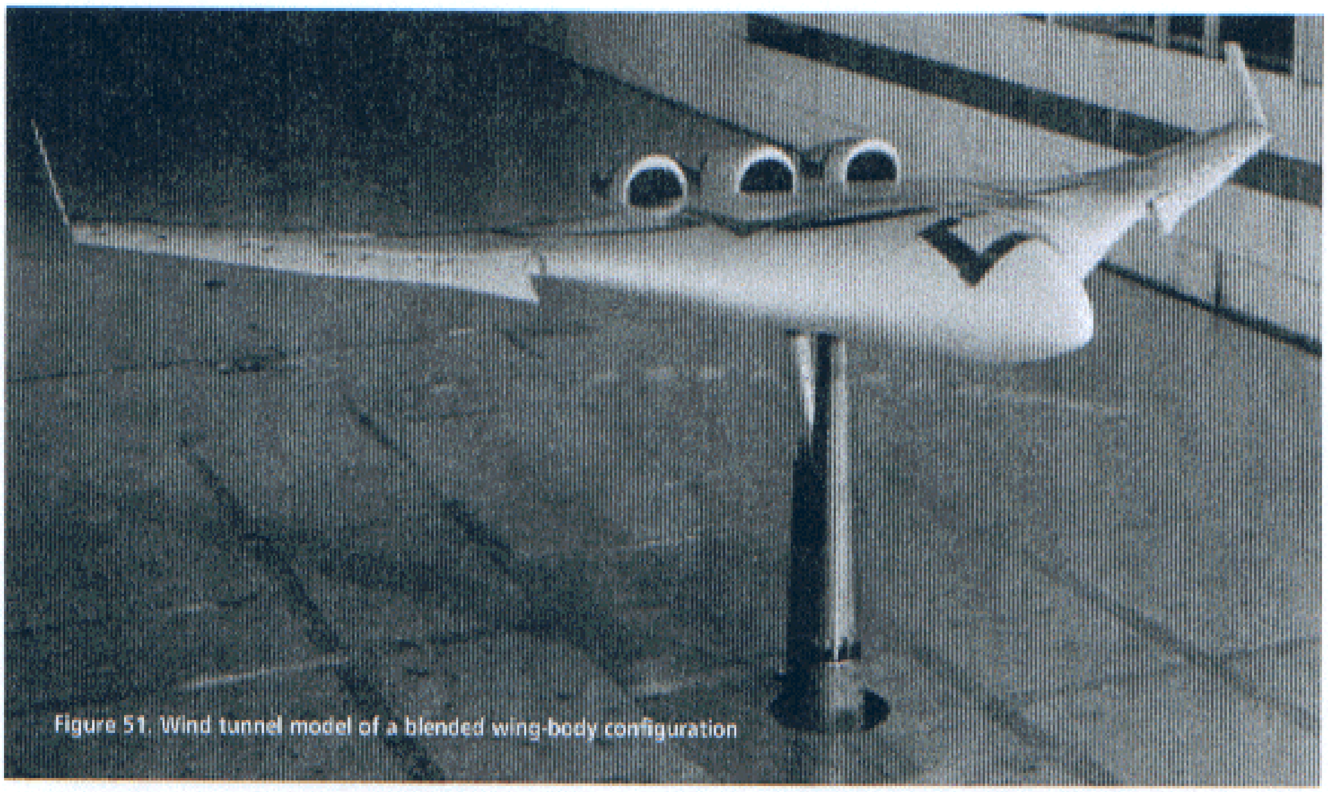

Figure 51. Wind tunnel model of a blended wing-body configuration

Aircraft Engine Emission Trends

- Current ICAO standards will not reduce emissions from most aircraft engines
- Trend toward improving fuel efficiency by increasing pressure ratio will increase NOx
- New noise standards could increase NOx
- Emission standards that require reductions in criteria pollutants and improved fuel efficiency are technically feasible with today's technologies

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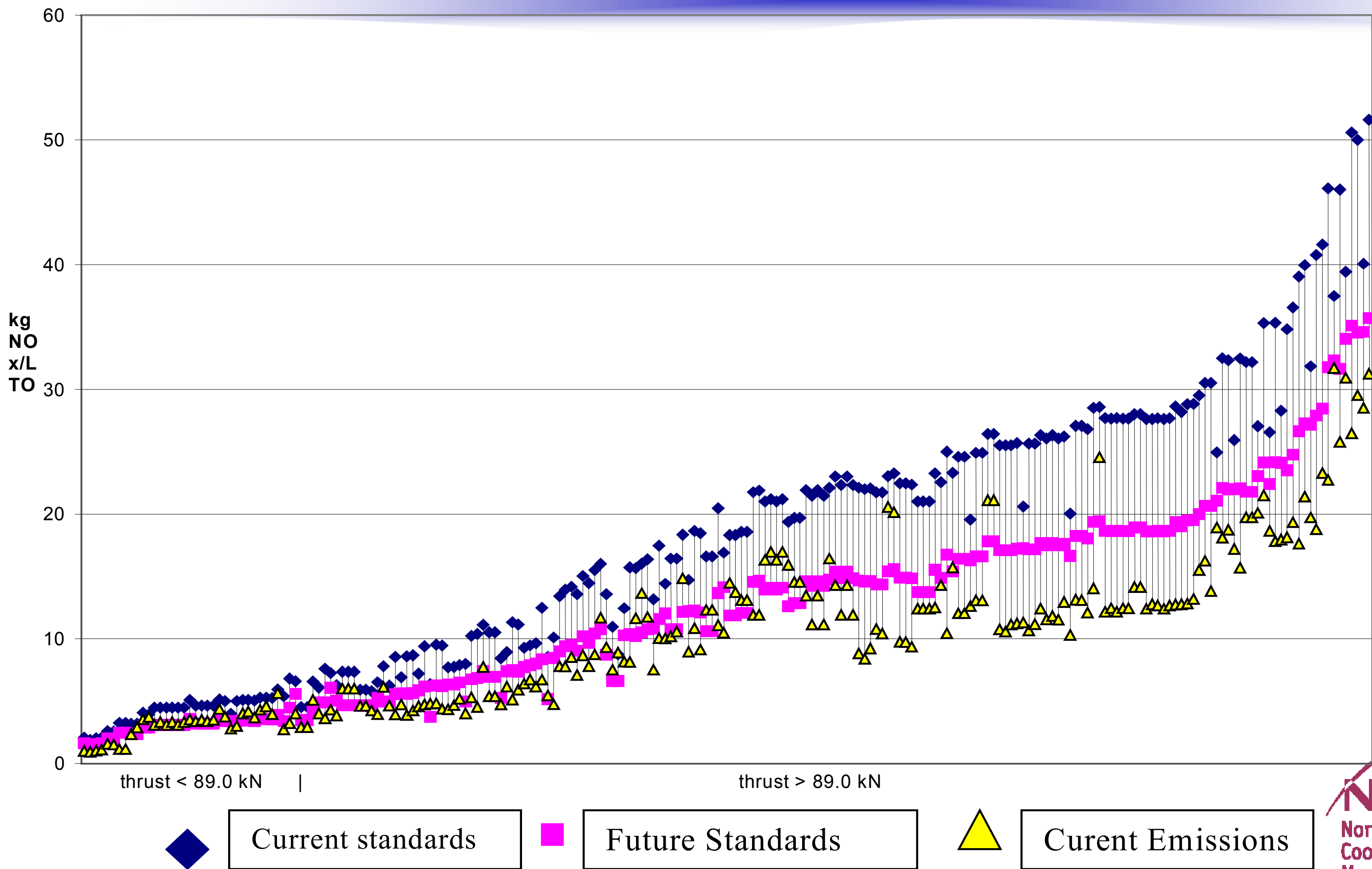
Aircraft Engine Emission Standards



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Aircraft Operational Measures

- Reduced use of reverse thrust
- Increased single engine taxi
- Increased use of fixed gate electricity
- Dispatch towing
- De-rated takeoff
- Decentralized gates
- Ground congestion reduction measures
- increased staging

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Cost Effectiveness of Options

Option	NOx emissions reduction	HC emissions reduction	CO emissions reduction	Other Benefits	Costs (dollars per ton of NOx + HC + CO reductions)
Dispatch Towing	.5-1%	.2-5%	2-5%	Reduces fuel consumption; may also help reduce ground congestion (esp. if high speed tugs are used).	Lifecycle costs are less than the alternative, so all emission reductions accrue for free
Decentralized Gates	3%	10%	10%	Reduced fuel consumption.	"
Ground Congestion Reduction Measures	3%	10%	10%	Reduced fuel consumption and travel delays for passengers; more efficient airport operation.	"
Reduced Engine Taxi	10%	30%	30%	Reduced fuel consumption; simple to implement.	"
Derated Take-off	10%	0%	0%	Reduced fuel consumption; simple to implement.	"
Reduced Reverse Thrust	5-10%	<1%	<1%	Reduced fuel consumption; simple to implement.	"

*note: some of the options above are already being implemented by air carriers

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Ground Support Equipment Options

- Replacement with natural gas or LPG (purpose built only)
- Replacement with electrically powered machines
- Replacement of gate power and air conditioning with electric fixed gate power
- Retrofit with emission control devices or fuel improvements

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Cost effectiveness of CNG/LPG

Measure	NMHC emission decrease	CO emission decrease	NOx emission decrease	Cost Effectiveness
CNG/LPG replacement of Diesel	30% (for properly calibrated, closed-loop systems)	30% (for properly calibrated, closed-loop systems)	65%	\$1,000 – \$3,000 per ton of VOC/CO/NOx combined
CNG/LPG Conversion from Gasoline	50% – 70%	45%	25%	Savings

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Cost Effectiveness of Electric GSE Use

Equipment	Fuel Type	ICE mainten-ance costs	Electric replace-ment mainten-ance costs	Total Cost Differen-tial ($/year)	Annual NOx reduc-tion	Lifetime NOx emission reduction (tons)	Cost Effectiveness ($/ton)
Baggage Tractor	Gasoline	1,461	1,472	794	0.4	3.4	1,900
	Diesel	1,461	1,411	1,337	0.2	2.4	5,800
Belt Loader	Gasoline	908	1,060	-668 (1)	0.2	2.1	Savings
	Diesel	908	1,060	-1,182	0.1	.8	Savings
Aircraft Tug	Gasoline	4,116	4,237	-810	0.8	5	Savings
	Diesel	4,116	4,152	1,470	0.5	5.3	2,800

Source: Arcadis report prepared for EPRI

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Gate Electrification

- Effective at reducing or eliminating auxilliary power and ground power unit emissions
- Can reduce or eliminate emissions associated with electricity, air conditioning, toilet disposal, fresh water delivery, food catering, baggage delivery, and refueling trucks

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Gate Electrification (cont.)

- Not all airports are suited for gate electrification (older airports)
- Operators are finding that payback period is relatively short (less than 2 years)
- LA, Phoenix, and Boston have replaced up to 90% of APU-based power with fixed gate power
- Can reduce GSE to aircraft accidents, maintenance, reduce complexity of ground operations

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Retrofit of GSE

- Three way catalysts for gasoline powered machines
- Oxidation catalysts or particulate filters/low sulfur diesel fuel with diesel machines
- Fuel changes such as emulsified diesel fuel or low sulfur diesel

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Ground Access Vehicle Technical Measures

- CNG
- Electric
- LPG
- Retrofit
- Fuel changes

Costs of Alternative Fuel Vehicles

Incremental Cost for Purchasing Alternative Fuel Vehicles

Vehicle type	Incremental purchase price for dedicated vehicle
CNG bus	$40,000
CNG light-duty vehicle	$3,000 to $5,000
Light-duty LPG	$2,000
Electric light-duty bus	$12,000 to $30,000
Electric heavy-duty bus	$125,000 to $225,000

Cost effectiveness of alternative fuel vehicle use

Vehicle type	Cost per ton of NOx, CO, HC, and PM reduced
Light-duty CNG	$8,000
Heavy-duty CNG	$14,000
Light-duty electric	$44,000
Heavy-duty electric	$37,000

*CO emissions are divided by 7 for the purpose of this analysis

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Ground Access Vehicle Operational Measures

- Compressed work schedules
- Ride sharing
- Increased use of public transit
- Telecommuting
- Reduced idling
- Congestion management

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Improved Intercity Rail Access/Service

- Improved rail service (high speed Acela) had reduced air travel trips by 7% in the Northeast corridor after the first four months of service
- Acela now serves Newark Airport
- Rail service has replaced air service between Paris and Brussels (air service cancelled)
- 6,300 tons of NOx could be reduced annually in the U.K. if domestic and half of foreign trips were switched to rail

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Auto-Air-Rail Comparison

Emissions comparison for 10,000 passengers, Toronto to Montreal

Mode	Fuel (kg)	HC (kg)	CO (kg)	NOx (kg)
Auto[1]	95,563	868	7,200	847
Air[2]	260,905	123	1,304	18,512
Rail[3]	44,310	105	319	2,338

1) 22 mpg, MY 1999 EPA emissions, 1.7 occupants
2) 50% Boeing 767-200, 50% Airbus 320, 70% load factor
3) 1-4-0 consist, 70% load factor

Source: prepared by Bombadier for the U.S. DOT Federal Railroad Administration

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Conclusions: Aircraft

- Aircraft engine emissions can be significantly reduced through the introduction of new and existing technologies
- Aircraft emissions can be significantly reduced though the introduction of innovative aircraft design
- Aircraft engine standards that encourage efficiency and low emissions are needed

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Conclusions: GSE, APU, and GPU

- Electric GSE provide the greatest emission reductions at the lowest overall cost of available GSE options
- Dedicated, purpose built alternative fuel GSE reduce emissions but at a greater cost than electric
- Gate electrification can cost effectively reduce APU and GPU emissions
- Retrofits can substantially reduce GSE emissions

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Conclusions: GAV and Rail

- Alternative fuel vehicles can significantly reduce GAV emissions
- Operational measures such as telecommuting and other options are cost effective
- Improved rail service can significantly reduce emissions

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