Fuel and Emission Reductions

Cost Savings for the US Air Transportation System

through implementation of

"Powered Electric Wheel Motor"

Cooperative Partnerships to create a "transportation environment" making air transportation more efficient, effective and responsible.

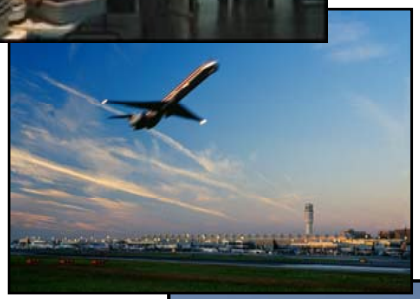
EPA AIRnovations 2005
Integrated & Innovative Approaches for Improving Air Quality

August 25, 2005

Carla R. York, CEO
Aircraft Innovation Technologies
Washington, DC

AIRCRAFT INNOVATION TECHNOLOGIES

Current Issues/Challenges in the ATS



- **AIRPORTS**
  - ✓ *Air Quality & Compliance*
  - ✓ *Personnel – Utilization and Security Issues*
  - ✓ *Security Issues*
  - ✓ *Asset and Personnel Utilization and Management*
  - ✓ *Ground Side Transportation & Parking Logistics*

- **AIRLINES & FREIGHT CARRIERS**
  - ✓ ***Fuel and Labor Costs***
  - ✓ ***Security Issues***
  - ✓ ***Asset Management***
  - ✓ ***Other Operational Costs (i.e. damage to AC)***

- **NATIONAL**
  - ✓ ***Environment (has large impact at Regional and Local levels)***
  - ✓ *Energy Security*
  - ✓ *Homeland Security*
  - ✓ *Economic Stability of Air Transportation System*

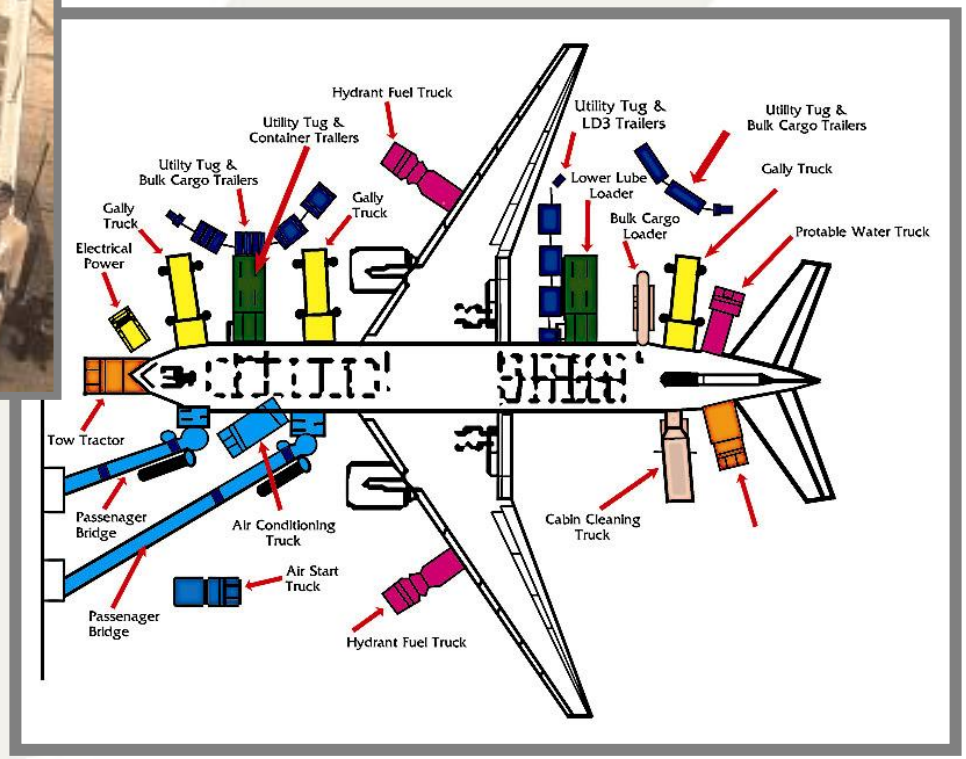
- **PASSENGERS – "The Flying Public"**
  - ✓ *Inconvenient Processing Procedures*
  - ✓ *Long Lines and Needless Delays*
  - ✓ *Poor Mobility Options at Airports*

AIRCRAFT INNOVATION TECHNOLOGIES

Aircraft Servicing

Ground Handling Circa 1956

Total GSE - 23



Ground Handling Present Day

Total GSE - 23

AIRCRAFT INNOVATION TECHNOLOGIES

Environment

- Air Quality and Visibility are impacted
- Emissions and associated health risks will worsen due increased fuel emissions of NOx , HC and CO.
- Ground noise pollution impacts worker health and safety.

Energy Security

- The US is an energy-intense society consuming 15 million barrels per day of petroleum in 2004 for all transportation needs.
- That number is expected to grow to 17 million barrels per day by 2010, of which nearly two thirds is imported based on projections from the US DOE.
- Airline operations in the US use 1.4+ million barrels of petroleum per day of which approximately 12 to 15% is consumed on the ground.
- There is no silver bullet for solving the US energy needs.

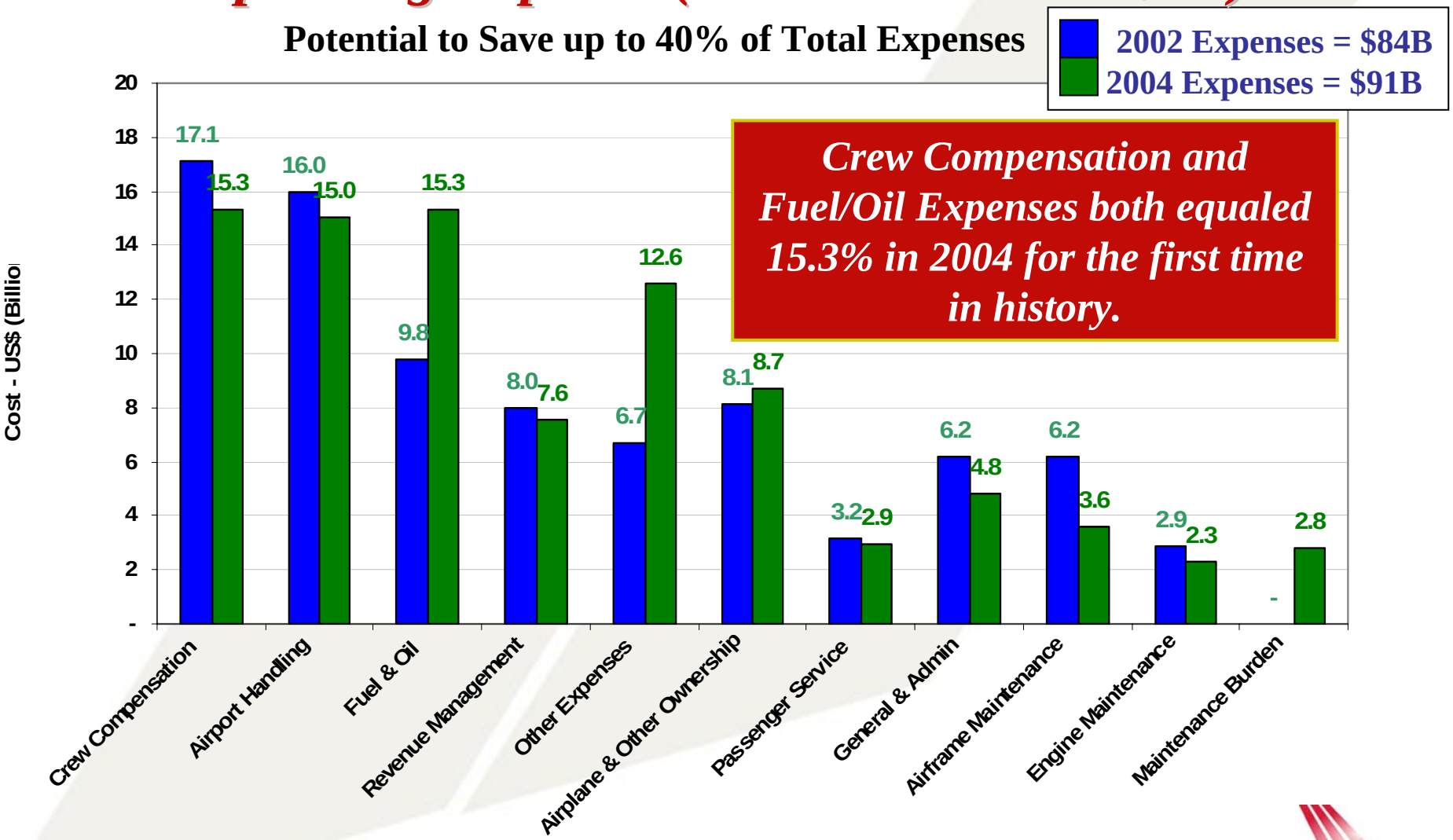
Homeland Security

- Terrorists Gaining Access to ATS
- Spotty Security Coverage in some areas of AOA
- Unsecured Baggage Carts
- Introduction of Threats into the Aircraft
- Number of Personnel around Aircraft

AIRCRAFT INNOVATION TECHNOLOGIES

2004 U.S. Passenger Airline
Operating Expense (Annual Revenue>$1B)

Potential to Save up to 40% of Total Expenses



Crew Compensation and Fuel/Oil Expenses both equaled 15.3% in 2004 for the first time in history.

Over the Next 20 Years $502 Billion Will Be Spent on Airport Handling Related Costs. *(Based on Dot Form 41 Data Forecasts)*

Source: USDOT Form 41

AIRCRAFT INNOVATION TECHNOLOGIES

Worldwide, the dollar equivalent of 15 Boeing 747-400s is lost each year to equipment damage during ramp operations.

A luggage container is stuck in a jet intake. Photo from www.boeing.com

Joint Planning and Development Office – USA

FAA

NASA

DOD

DHS

DOC

Projections

- Cargo will triple or even grow five fold by 2025
- Domestic passenger traffic to double by 2025
- International passenger traffic to triple by 2025

Their Transformed System Goals:

Reduce aviation system costs by 25%.

Create 100's of thousands of new jobs.

Provide three times the current capacity.

Meet future air transportation demand.

Reduce curb-to-curb transit time 30%.

Limit passenger time in airport to less than 30 minutes.

95% of aircraft arrivals & departures to be on-time.

Seamless security with other aviation operations.

Maintain aviation as safest mode of travel.

Retain role as aviation world leader.

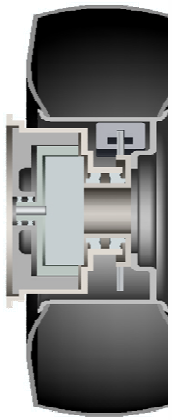
EU – Vision 2020 Main Points

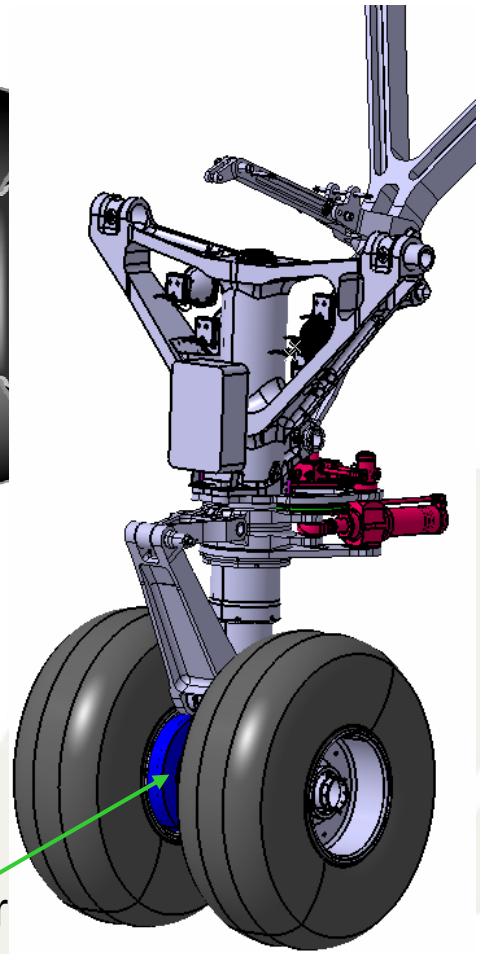
- Reduce perceived noise by ½
- 50% reduction in CO_2 , 80% reduction in NO_x , 50% better SFC
- 99% on time departure
- 5 fold reduction in aircraft accidents
- Seamless European ATM system
- Integrated Multimodal Transport system
- Half Time to Market for new aircraft introductions

AIRCRAFT INNOVATION TECHNOLOGIES

Where Is the Solution?
The Powered Electric Wheel Motor

DRS





Production Unit

Technical Maturity

- Motor developed for other industries (target is 1 to 3 kg/kW).
- Tow-test data showed 22hp moved 252,000 lb 767-400 at 14 mph on level ground in May 2004.
- Phase 1 test to validate concept viability.
- Flight-ready could be completed and ready for installations by late 2007 or early 2008.

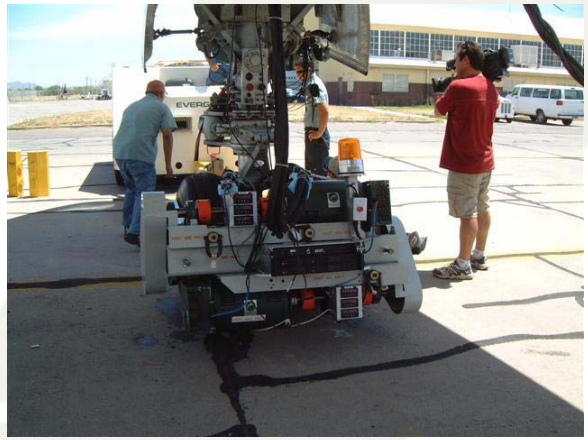
Why A Powered Wheel ?

- Autonomous gate operations, eliminates need for tug;
- Major step toward a “vehicle free” ramp;
- Reduces main engine use;
- Reduces ground fuel burn, noise and jet blast;
- Improves safety;
- Fewer ramp personnel improves overall security;
- Helps address environmental issues.

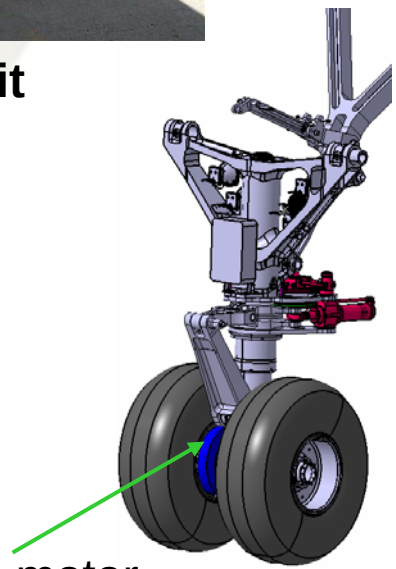
AIRCRAFT INNOVATION TECHNOLOGIES

Proof of Concept Motor – Tested June 2005 at Evergreen Field in AZ

- *Existing motor*
  - 6000 ft-lb at the wheel
  - 12:1 gear ratio
  - Forward and reverse
  - Full pilot control
- *Strap on design*
  - No airplane system interfaces
  - Power from cargo mounted auxiliary engine
  - Hand held controls
  - Lab tested design and control
- *Results*
  - Positive results from all test maneuvers completed with two lead pilots in the cockpit.
  - Results validated concepts.



Test Unit



Production Unit

AIRCRAFT INNOVATION TECHNOLOGIES

Aircraft Freight

- Domestic Freight Shipment Value by Mode (2002)

  Truck: 75% **Air: 15%** Rail: 4% Waterborne (domestic): 1% Other: 5%

Source: Bureau of Transportation Statistics and U.S. Census Bureau, 2002 Commodity Flow Survey

Aircraft Fuel - Freight

- Fuel Consumption by Domestic Freight Mode, 1990-2001 – *annual consumption*
  - Truck: 35 billion gallons **Air: 15 billion gallons (domestic only)**
  - Water: 5 billion gallons (domestic only) Rail: 4.5 billion gallons

Source: Bureau of Transportation Statistics, National Transportation Statistics 2003 (air, waterborne, rail); Federal Highway Administration, Highway Statistics (truck)

Aircraft Growth

- Domestic Freight Demand Forecasts (historic data annual growth – ton-miles) (1990-2000)

  Air: 5.2% (domestic) Truck: 3.9% Rail: 3.6% Water: -2.5% (domestic)

  Sources: BTS, AASHTO, ATA, and ICF

Freight Transportation NOx Emissions (2002-2020)

	2002	2010	2020
Air (increases 6x)	**0.2%**	**0.5%**	**1.2%**

Freight Transportation PM Emissions (2002-2020)

	2002	2010	2020
Air (increases 2x)	**0.4%**	**0.6%**	**0.7%**

AIRCRAFT INNOVATION TECHNOLOGIES

Fuel Savings by Model

Boeing Commercial Fleet

Boeing aircraft account for approximately 60% of the US market. We show the cumulative savings for this fleet and hope to include all other fleets in the near-term.

Aircraft Model & # of AC	Annual Barrels Saved / Model
#707-720 (270)	1,286,738
#727 (820)	3,070,243
#737 (3,791)	25,940,625
#747 (1,026)	2,085,174
#757 (1,004)	8,262,501
#767 (838)	6,547,648
#777 (420)	2,073,964

Total Savings of 49,266,893 Barrels of refined fuel or 57,961,051 Barrels of Petroleum could be saved under optimal conditions.

Emissions Savings:

HC* decrease approximately 119,750 TPY

CO* by approximately 495,303 TPY

NOx* by approximately 65,650 TPY

Fuel savings shown are based on **conservative** operating conditions; all aircraft experience no delays entering or exiting the ally and proceed directly to the runway for immediate takeoff. When delays are factored in, the savings could be 35%-40% greater than shown.

Petroleum Savings – Barrels and Dollars

March 11, 2004 Crude price of $31.03 per barrel (US DOE)

Daily Savings $4,927,483

One Year Later – 84.66% Increase in prices of Crude Oil

Same Fuel Reductions would add up to much greater cost savings

March 17, 2005 Crude price of $57.30 per barrel (Dow Exchange/ Transport Topics / CNN)

Daily Savings $9,099,091

AIRCRAFT INNOVATION TECHNOLOGIES

1 Atlanta Journal and Constitution; October 19, 2004; "Record Oil Prices Worsen Bleak Outlook for Airlines"

Potential Benefits Example
Southwest Airlines

- Eliminate 22 minutes of main engine use per LTO and **save $196 per LTO**
- Approximately 792 gallons/737 could be saved based on 6 flights per day
- 312 days per year of operation nets approximately **247,104 gallons of fuel saved per 737 aircraft**
- June 2005 fuel cost of $1.65/gallon would equal approximately **$407,722 in cost savings per 737 aircraft.**
- Additional savings would be realized through reduced engine maintenance, elimination of tug/driver, ground maintenance and other applications such as hangar-to-terminal movements.
- **In 2004, Southwest Airlines posted 905,262 departures. Had the Powered Wheel been employed on those aircraft, 119,494,584 gallons of fuel could have been saved; generating several million dollars in additional revenue – after recapturing the investment cost.**

737–300 emissions during 22 minute period is equivalent to 41 Class VIII Diesel Trucks.[1]

1 Based on DOT/FAA published fuel use and EPA emissions data for both vehicles.

AIRCRAFT INNOVATION TECHNOLOGIES

IAH 2004 LTO's Fuel/Emissions

Bush Intercontinental Airport – Houston, TX

USING POWERED ELECTRIC WHEEL MOTOR

Houston TX *- August 2004 fuel prices of $1.58/gallon and $1.90 per minute*

- Estimated taxi time **minutes saved** / operation = 16
- Total taxi time **HOURS / Year saved** = 122,251

ANNUAL FUEL SAVINGS @ $1.58/gallon > $13,936,430

Emissions Savings - Representative

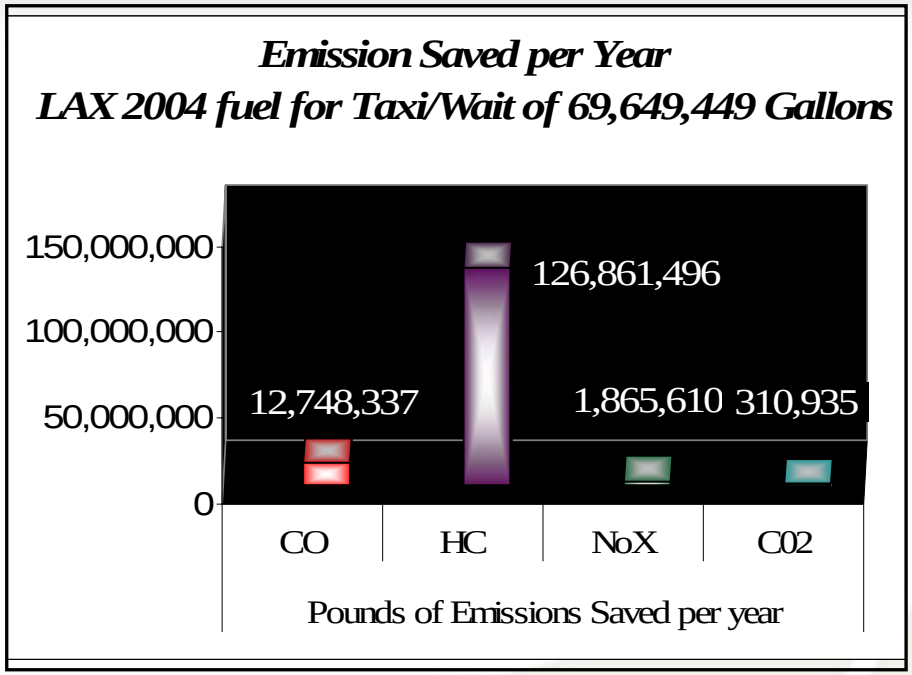
Emissions Savings – conservatively calculated at 16 minutes by the airport.
Does not include additional emissions from delays or other ground maneuvers other than TAXI.

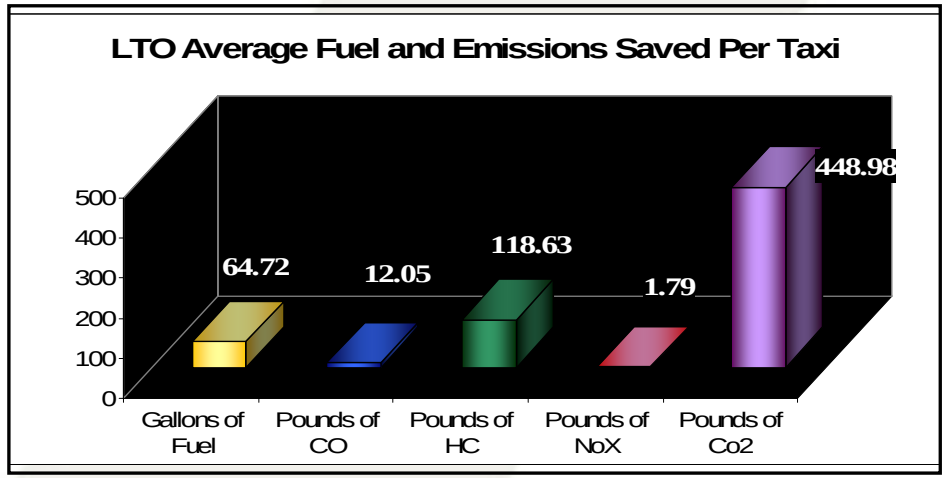
HC would decrease 121 Tons; CO by 1,457 Tons;
NOx by 273 Tons; SOX by 64 Tons

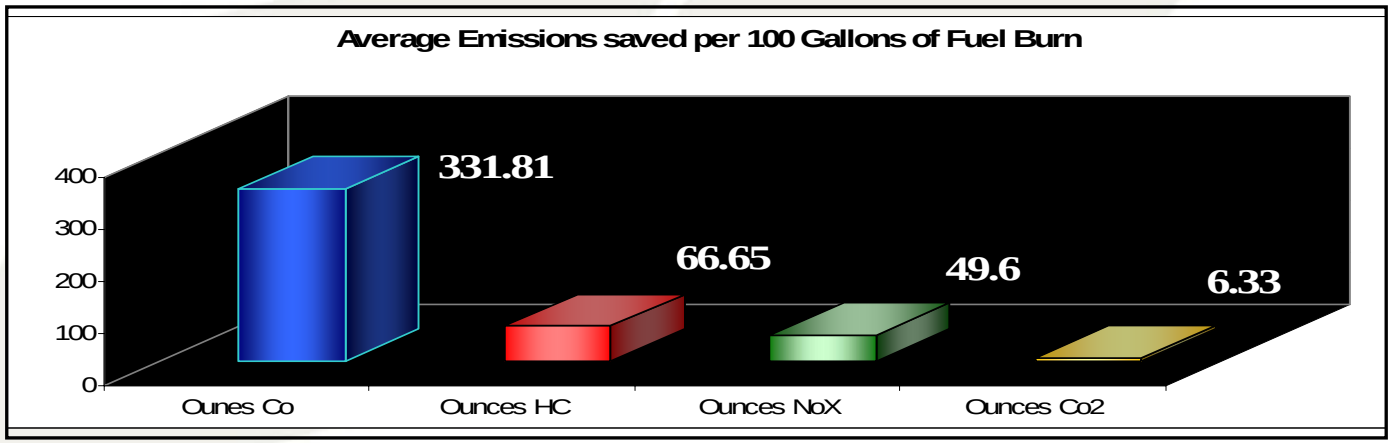
Validations for National Fleet currently being calculated.
274,536 LTO's commercial aviation only were calculated for the airport,
by airport personnel utilizing EDMS Modeling Software from EPA/FAA.

AIRCRAFT INNOVATION TECHNOLOGIES

LAX 2004 LTO's Fuel/Emissions







Data from LAX Environmental Report & Emissions Reductions are based on LAX Data inputs for fuel, taxi/wait time & AC engines. All calculations from EDMS Software.

AIRCRAFT INNOVATION TECHNOLOGIES

Program Phases

- Phase I (2006-2008): Aircraft Idle Reduction
  - **Use of Electric Wheel Motor**
    - Final Development
    - In-service Flight Demonstration and FAA Certification
    - Fleet Implementations – Domestic and International
- Phase II (2008-2010): Airport Ground Service Improvement
  - **Automated Ground Service**
    - Consensus Building (FAA, Airlines, Airports, Others)
    - Design and Build Prototype
    - Site Demonstration – Houston IAH (Gate D12)
    - Implementations 2010-2025
- Phase III (2006-2015): Landside and Terminal Improvements
  - **Efficiency and Security Improvements**
    - Consensus Building and coupling of technology sets with operational needs
    - Pilot Studies – Variety of technologies and processes demonstrated and tested across the country at a variety of airports
    - Implementations 2008-2015

Air Side – Project Outline

Objectives

- Reduce Petroleum Fuel Usage by aircraft during Ground Operations through implementation of “Powered Electric Wheel Motor” on aircraft to provide mobility and reduce main engine usage.
- Reduce turn-around time of Aircraft through long-term, 15 years+ development and implementation of *Automated Gate* for aircraft servicing.
- Reduce damage to aircraft and employee injury risk through implementation of “Powered Electric Wheel Motor” and *Automated Gate*.
- Improve security on the ramp through implementation of *Automated Gate* and removal of GSE from ramp area (many employees would be relocated within the airport system).

AIRCRAFT INNOVATION TECHNOLOGIES

Collaborating with EPA

- **Voluntary Programs**
  SmartWay Transport Partnership is a freight-based, government-industry partnership aimed at conserving fuel and reducing emissions
  - Boeing project is consistent with SmartWay and allows expansion of SmartWay to include airports/aircraft
- **Reputation**
  Idle reduction program has an excellent reputation
  - Competence and Trust

SmartWay Transport Airport

- Reduce Petroleum Fuel Usage by **all** vehicles on airport property by implementing idle reduction technologies, converting to alternative fuels in newer vehicles and eventually by replacing existing vehicles with new vehicle technologies designed for use of alternative fuels.
- Development of new transit vehicles for servicing the Terminal from the parking lots that would utilize clean alternative fuels as well as offer passenger comforts and features currently not available or utilized.
- Work with Car Rental Companies to combine and streamline service provided as well as implementing clean alternative fuels.
- Work with Airports, OEMs and Fuel Providers to convert all airport vehicles to alternative fuel sources.
- Land Side program will take several years to fully develop and implement and will offer opportunities for all clean, domestic “alternative fuels” to participate.

Industry Leadership Team

AIRCRAFT INNOVATION TECHNOLOGIES

BOEING PHANTOM WORKS

HOUSTON AIRPORT SYSTEM
BUSH INTERCONTINENTAL / HOBBY / ELLINGTON

Other Organizations Involved

UPS

UNITED

Delta

Continental Airlines

AIR CANADA

DFW

MCGHEE TYSON AIRPORT
KNOXVILLE

BRADLEY INTERNATIONAL

INNOVATION DRIVE

Edwards AND Kelcey

Ford

KAPTURENET

GLOBALENERGY CONSERVATIONGROUP,LLC

MES

Sabre Engineering Inc.

CHORUS MOTORS PLC

HYDROGENICS CORPORATION

OAK RIDGE NATIONAL LABORATORY
Managed by UT Battelle for the Department of Energy

HYDROGEN ENERGY SYSTEMS
AVALENCE LLC

AIRCRAFT INNOVATION TECHNOLOGIES

Government

The Following Agencies have been briefed on the program efforts and are listed in the order of support and assistance received to date from each agency.

CEQ	-	Council of Environmental Quality
EPA	-	Environmental Protection Agency
FAA	-	Federal Aviation Administration
DHS	-	Homeland Security
DOD	-	Department of Defense
JPDO	-	Joint Planning and Development Office
DOT	-	Department of Transportation
DOE	-	Department of Energy
FTA	-	Federal Transit Administration
NTSB	-	National Transportation Safety Board

Council on Environmental Quality

AIRCRAFT INNOVATION TECHNOLOGIES

Thank you for your time and attention

For more information, please contact

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