JPDO Environmental Working Group Operations Standing Committee’s E-Workshop

Atlantic Interoperability Initiative to Reduce Emissions (AIRE) – Environmental Program Status

For: Members of EWG
By: Sandy Liu, FAA Office of Environment & Energy
On: 28 July 2009 in NASA Ames Res Cntr
Topics of Discussion

• AIRE (& ASPIRE) – Environmental Goals
• Mission Segments Gains:
  - Arrivals
    (MIA/ATL CDA, ATL1.5, MIA TAs, LAX, SDF, etc)
  - Oceanic (AEA)
  - Surface
• Est. Industry Cost Benefit & Environmental Mitigation Progress
• FY09 Integrated Oceanic & Arrival Effort
• Next Step
AIRE & ASPIRE Goals (Addressing both Oceans)

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

- Reduce aviation’s environmental footprint via environmentally friendly procedures

- All flight segments (gate-to-gate)
  - Surface
  - Oceanic
  - Arrivals

- Near term goals
  - Coordinate operational demonstrations
  - Validate environmental improvements

FAA Approach:
To define and implement environmentally efficient operational activities for the NAS and support system demonstrations leading to NextGen advancements for Surface, Departure, En route/Oceanic and Arrival operations.
Environmental Approach

• The AIRE domain demonstrations are *proof of concept* ATM system enhancements that have been shown to offer major environmental benefits from improved operational efficiency.

• For each AIRE domain technology/technique, levels of fuel savings/emission and noise reductions will be quantified for the participating trans-Atlantic flights.

• Metrics will identify the overall potential for engine emissions and aircraft noise reduction.
## AIRE Environmental Potential
(Reduce fuel burn, emissions & noise)

<table>
<thead>
<tr>
<th>Domain - Demonstration Technology</th>
<th>Operational Metric (source)</th>
<th>Environmental Metric - Fuel Burn, lbs*</th>
<th>Est. Potential Fuel Saving (Margin of improvement non-weighted)</th>
<th>Baseline (rel. ops levels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Taxi time measured</td>
<td>Derived using ICAO Engine Performance Data</td>
<td>2%</td>
<td>MEM historical ops &amp; JFK ops (w/o ASDE-X) Vs Installed ASDE-X</td>
</tr>
<tr>
<td>Oceanic</td>
<td>Fuel burn calc/measured</td>
<td>As measured by Airline participant(s)</td>
<td>4%</td>
<td>Filed Flight Plan Vs Actual Flight Profile</td>
</tr>
<tr>
<td>Arrival</td>
<td>Flight Trajectories measured</td>
<td>Derived by Aviation Environmental Design Tool (AEDT) or ICAO BADA equivalent</td>
<td>2%</td>
<td>Pre CDA/TA Operations Vs Newly developed CDA/TA</td>
</tr>
</tbody>
</table>
Environmental Potential (Margin)—
IPCC estimation of Aviation CO2 influence, ref CANSO report ATM Global Environmental Efficiency Goals for 2050

Global ATM Margin Range
~3 %
Efficiency Mechanisms

**SURFACE (12%)**
- Min APU use or alt clean power
- “just in time” refueling
- Min taxi time & holds (continuous transit)

**DEPARTURE (3%)**
- Use of Maximum climb power

**ARRIVAL (25%)**
- Request optimal vertical – CDA/OPD/TA/TAPS
- Delayed flaps

**OCEANIC (60%)**
- Use of UPR-User Preferred Routes—updated winds
- Use of DARP - Dynamic Airborne Reroute Procedure - shorten path
- Operate at optimum altitude/flight level
- Cost Index (economy speed)
Arrivals Savings – Flight Trials/Demos/Ops

Heavy Aircraft - (747, 767, 777, 330)
Turbojet - (737, 757, 320)
LAX mixed fleet avg estimate 07-08
Oceanic Savings- AIRE & ASPIRE

Idealized Flight Operations

Currently Available Technology

Gate-to-Gate Flight Distance (nm)

Fuel Saved, rel. a/c fuel capacity
FY08 AIRE Fuel Savings

- **Est. ATC Margin**
- **Wt’d by mechanisms**
- **AIRE**

**Domains**
- Surface
- Oceanic
- CDA/TA
- Cum

- Surface: 0.30%
- Oceanic: 2.40%
- CDA/TA: 0.50%
- Cum: 3.2%

**FY08 AIRE Fuel Savings**
## Industry Benefit

<table>
<thead>
<tr>
<th>CY2008 Activities</th>
<th>Demonstration</th>
<th>AIRE/ASPIRE Benefits</th>
<th>Cost Saving@ $3.08/gal (10/3/08)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic TBO</td>
<td>May Demo- Completed</td>
<td>~ 47 gals/flt</td>
<td>~$145/flt</td>
</tr>
<tr>
<td>CDAs @ ATL/ MIA</td>
<td>May Demo- Completed</td>
<td>~38-50 gals/flt</td>
<td>~$150/flt</td>
</tr>
<tr>
<td>ASD-X@MEM/JFK</td>
<td>Recently activated</td>
<td>est~ 50 gals/flt</td>
<td>~$150/ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Spain to Caribbean Islands</th>
<th>AIRE Cumulative Total:</th>
<th>Est. 150 gal/flt X 40 flts/wk</th>
<th>$960K/annually</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Ideal Gate to Gate Australia/ NZ- US/Can</th>
<th>ASPIRE Cumulative Total:</th>
<th>Est. 1174 gals/flt X 156 flt/wk</th>
<th>$29M/annually</th>
</tr>
</thead>
</table>
Projected Annual Environmental Benefits
AIRE Current Spain to Caribbean Islands

CO2 Emissions Equivalencies for ASPIRE Demo:

Can potentially save 3K metric tons CO2 = (40 flt ops/wk )
- Annual greenhouse gas emissions from 500 passenger vehicles

Energy:
- CO2 emissions from 312,000 gallons or 6,400 barrels of oil consumed
- CO2 emissions from the electricity use of 365 homes for one year

Off-set Mitigation:
- Carbon sequestered by 70,500 tree seedlings grown for 10 years

Relative to Nature’s Cycle:
- Carbon sequestered annually by 625 acres of pine or fir forests

Conservation:
- CO2 emissions avoided by recycling 1,000 tons of waste instead of sending it to the landfill
Projected Annual Environmental Benefits
ASPIRE Pacific Flts between Australia/New Zealand to USA/Canada

CO2 Emissions Equivalencies for ASPIRE Demo:
Can potentially save 83K metric tons CO2 = (Optimal 154 flt ops/wk)
• Annual greenhouse gas emissions from 15,000 passenger vehicles

Energy:
• CO2 emissions from 9,442,000 gallons or 194,000 barrels of oil consumed
• CO2 emissions from the electricity use of 7,340 homes for one year

Off-set Mitigation:
• Carbon sequestered by 2M tree seedlings grown for 10 years

Relative to Nature’s Cycle:
• Carbon sequestered annually by 19,000 acres of pine or fir forests

Conservation:
• CO2 emissions avoided by recycling 29,000 tons of waste instead of sending it to the landfill
AIRE Airline Partners

AirEuropa.com

American Airline
AIRE Oceanic/TA Flights

AIRFRANCE

Lufthansa
AIRE Oceanic/TA Flights
Next Step
Metrics: Data Collection & Analysis
Storing & Sharing Flight Measures

Record actual:
- Fuel Burn (lbs or gals) – PRIMARY Metric
- Payload
- Trajectory
- Meteorological – winds/temp

Compute prediction:
- CO2 emissions - convert from fuel use
- Noise in terminal area (optional)
Proposed Data Collection Methods

• Pilot/flight crew Data Log recording
  – Baseline (prior 1-month ops)
  – Demo flights (as scheduled)

• Cockpit Flight Data Recorder/Flight Operations Quality Assurance system
  – Baseline (prior 1-month ops)
  – Demo flights (as scheduled)

• Airline Operations Center and Aviation Navigation Service Provider(s) System data
  – Filed Flight Plans information/data
  – Simultaneous AOC data of flight Baselines & Demo flights
AEDT overview

Airports Database
Aircraft Fleet Database
Movements Database
Non-aircraft Sources Database
Study-Specific Database

Calculate Pollutant Concentrations
Total Noise & Emissions Results Database
Calculate Additional Noise Metrics
GIS Capability

Graphical User Interface or Advanced Input Files

Fly Aircraft
Aircraft Performance + Fuel Burn

Calculate Noise
SEL, Time Audible, Lmax, Time Above

Calculate Emissions
All Pollutants + GHGs

Weather Calculations
Terrain Calculations

Repeat for all Flights

Fuel Burn & Emissions Inventories
Noise & Pollutants Grids
Noise Change Analyses
Contours

Outputs
AEDT Performance Improvement

• Boeing and the FAA recently exchanged software tools – the Boeing Climb-Out Program (BCOP) and the FAA’s Integrated Noise Model (INM).
  – FAA provided Boeing an executable version of the INM for inclusion in the next version of BCOP and in next generation performance tools
  – Boeing provided the FAA a copy of BCOP

• BCOP contains terminal area fuel burn data, for both departure and arrival
AEDT Fuel Burn Methodology

• Using BCOP, we developed two fuel consumption methods

Departure:

\[ \frac{TSFC}{\sqrt{\theta}} = k_1 + k_2 M + k_3 h_{MSL} + k_4 \frac{F}{\delta} \]

Arrival:

\[ \frac{TSFC}{\sqrt{\theta}} = \alpha + \beta_1 M + \beta_2 e^{-\beta_3 \left( \frac{F}{\delta} / F_0 \right)} \]
AEDT Model v. Actual: Miami, Sept 2008, 777-200ER

<table>
<thead>
<tr>
<th>Tailored Arrival Flight</th>
<th>Arrival Runway</th>
<th>Fuel Burn FDR (kg)</th>
<th>Fuel Burn AEDT (kg)</th>
<th>Delta (kg)</th>
<th>Delta (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>08L</td>
<td>3112</td>
<td>2942</td>
<td>-170</td>
<td>-5.5%</td>
</tr>
<tr>
<td>2</td>
<td>08R</td>
<td>3278</td>
<td>3367</td>
<td>+89</td>
<td>+2.7%</td>
</tr>
<tr>
<td>3</td>
<td>08L</td>
<td>3029</td>
<td>3063</td>
<td>+34</td>
<td>+1.1%</td>
</tr>
</tbody>
</table>
Potential effects contributing to the Wide Range fuel savings identified (SFO 200 gals vs MIA 50gal)

Factor contributing:
• Lateral track length (ref. way pt/fixes)
• Accountability of typical vectored paths in SA
• Characteristics unique to each airport envir
• no. of data samples
• Modeling assumptions, i.e., BADA, INM/BCOP, etc

ACTION:
Explore an approach/metric that reflects saving in generic manner for national comparison as well as qualify with variability range/bars when available.

<table>
<thead>
<tr>
<th>airport</th>
<th>SA</th>
<th>TA</th>
<th>savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFO</td>
<td>ineff</td>
<td>eff</td>
<td>high</td>
</tr>
<tr>
<td>MIA</td>
<td>eff</td>
<td>ineff</td>
<td>low</td>
</tr>
</tbody>
</table>
Summary

• Exploring major segments of flight for efficiency gains. More on surface and departure needed.

• Modeling capability is maturing and more data flowing to support benefits.

• Incremental buildup of NextGen is progressing positively for Environment. But many questions to answer…

• Environmental ATM mitigation has started.
Back-up slides
OPD-CD into ATL Notre (West ops)

Total Samples:
CD – 75 flts
Std- 290 flts

Savings:
794 lbs - 435 lbs = 359 lbs (165 kg)
55 gals
1150 lbs CO2/flt