AVIATION OPERATIONAL MEASURES FOR FUEL AND EMISSIONS REDUCTION WORKSHOP

Aircraft Operating Procedures to Reduce Airport Ground Emissions

Captain Richard Sowden
Project Pilot Air Canada Flight Operations Technical Group

Airport Panel – Part 1
Ottawa, 5-6 November 2002
Objectives

» Describe aircraft operating techniques to reduce aircraft noise and engine emissions for phases of flight below 3,000 ft. AGL

» Review strategies to ensure success

» Outline means to measure success

» Discuss conflicting environmental objectives

» Discuss the collective industry effort required to achieve the greatest enhancements in efficiency
Efficiency Assumptions

» A320 aircraft
» 100 aircraft in fleet
» 15,000 sectors/month or 180,000 sectors/year
» Every 100 litres of fuel burned releases the following combustion by-products
  - CO₂ – 233 kg
  - CH₄ – 219 g
  - NOₓ – 23 g
Pre-departure

» Minimize APU use

– Start APU 10 minutes before scheduled departure time

• Reducing APU use by 2 minutes per sector saves 780,000 litres of fuel annually

– APU vs. Ground Support equipment

• APU burns 6 times as much fuel per hour as mobile ground support equipment (B744 - 20X)

– Requires precise procedures & dedicated effort by ground handling teams

Airport Panel – Part 1
Ottawa, 5-6 November 2002
Engine Start & Taxi

» Single engine taxi should be the normal departure procedure unless conditions preclude it
  – 1 minute of single engine taxi-out per sector saves 430,000 litres of fuel annually

» Five key areas to focus on in Standard Operating Procedures (SOP’s)
  – Limiting weight
  – Limiting thrust
  – Checklists
  – Engine start sequence
  – Stabilization times
Takeoff

» “Flex Thrust” normal operating procedure
  – Reduces noise
  – Reduces overall sector fuel consumption
  – Reduces gas path wear & maintenance costs
  – Currently 85% of A320 family departures are “Flex Thrust”

» Depart in direction of flight
  – Airborne fuel flow is 6 times higher than ground idle - 18 min. taxi = 3 minutes airborne
Initial Climb

» Climb profile tailored to direction of flight for turns limited by altitude due to noise abatement requirements

- Use $V_2 + 10$ to $3,000$ ft AGL for altitude restricted SID’s when departure runway is more than $90^\circ$ from direction of flight

- Used on $1/3$ of departures saves $3.2$ million litres of fuel annually
Approach

» RNAV arrivals
  – Enhanced traffic & energy management
  – Reducing IFR arrival distance by 4 miles saves 50 litres of fuel

» Decelerated approaches as normal SOP
  – Flap/gear selection defined by altitudes
  – Used on 1/3 of arrivals saves 4.5 million litres of fuel per year
Landing

» Reduced flap landings as normal SOP
  – Quieter approaches
  – Used on 1/3 of landings saves 3 million litres per year of fuel

» Idle reverse as normal SOP
  – Quieter & can improve carbon brake wear
  – Reduced gas path wear & maintenance costs
  – Used on 1/3 of landings saves 1.2 million litres of fuel per year
Single engine taxi should be the normal arrival procedure unless conditions preclude it.

- 1 minute of single engine taxi-in per sector saves 430,000 litres of fuel annually.
Gate Arrival

Minimize APU use with full ground support on arrival at gate

- Start APU 10 minutes before scheduled departure time
  - Reducing APU use by 2 minutes per sector saves 780,000 litres of fuel annually

- APU vs. Ground Support equipment
  - APU burns 6 times as much fuel per hour as mobile ground support equipment (B744 - 20X)

- Requires precise procedures & dedicated effort by ground handling teams

Airport Panel – Part 1
Ottawa, 5-6 November 2002
### Achievable Fuel Savings

A fleet of 100 A320 aircraft flying 15,000 sectors a month can save:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Fuel Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-departure</td>
<td>780,000 litres</td>
</tr>
<tr>
<td>Taxi-out</td>
<td>430,000 litres</td>
</tr>
<tr>
<td>Initial climb</td>
<td>3,200,000 litres</td>
</tr>
<tr>
<td>Approach</td>
<td>4,500,000 litres</td>
</tr>
<tr>
<td>Landing</td>
<td>3,000,000 litres</td>
</tr>
<tr>
<td>Taxi-in</td>
<td>430,000 litres</td>
</tr>
<tr>
<td>Gate arrival</td>
<td>780,000 litres</td>
</tr>
</tbody>
</table>

**Total**: 13,120,000 litres (1.25%)
Fuel Savings Impact

» Operating cost reduction through reduced fuel consumption
  – $3.25 million US

» Emission reductions through reduced fuel consumption
  – CO₂ – 12.2 million kg
  – CH₄ – 11,500 kg
  – NOₓ – 1200 kg
Strategies for Success

» Build an efficient operating culture

- Top down management support
- Policy to define fuel efficiency as a corporate objective, but not at the expense of safety
- Procedures that:
  - Establish fuel efficient procedures as the norm
  - Recognize conservative, safety oriented pilot culture
- Education & awareness material to explain “why”
- Training to teach the SOP
- Checking to reinforce the SOP
Measuring Success

» Fuel Management Information Database
  – Capture flight plan and actual aircraft operating fuel values
  – Validate policy & systems

» Flight Operations Quality Assurance (FOQA)
  – Capture aircraft flight profiles
  – Validate procedures and compliance rates

» Maintenance QAR & ACARS data
  – Trending information pending introduction of FOQA

» Clear employee non-judgmental clauses required
Conflicting Environmental Objectives

Centralized de-icing facilities

- Reduce glycol contamination
- Incur significant taxi-out delays thereby increasing engine emissions
- 30 minute deicing taxi event burns
  - A320  400 litres
  - B747-400 3300 litres
Conflicting Environmental Objectives... 2

» Noise abatement procedures (N. Am):
  – Preferential runways and arrival/departure procedures are:
    – Based on track/altitude monitoring
    – Do not reflect actual aircraft noise or promote noise and fuel efficiency
    – Have not been revisited for years
    – Are not based on reasoned scientific and engineering analysis or evolution of aircraft technology
An Industry Integrated Approach to Fuel Efficiency

» Airlines
  – Develop and implement fuel efficient SOP’s

» ANS Providers
  – Develop and implement fuel efficient arrival and departure paths

» Airports
  – Maximize on-gate de-icing & minimize CDF delays
  – Facilitate departures in direction of flight
  – Ensure noise abatement procedures minimize adverse affect on fuel burns
» Aircraft Manufacturers

– Introduce fuel efficiency improvements to aircraft in a timely manner to support the industry

– Examples of needed aircraft modifications:

1. A320 family aircraft approach idle change to Flap 3 or gear down from Flap 1 would save 12 litres of fuel per approach

2. Bombardier Regional Jet Flap 30 landing instead of Flap 45 would save 18 litres of fuel per approach
AVIATION OPERATIONAL MEASURES FOR FUEL AND EMISSIONS REDUCTION WORKSHOP

Thank you!

Contact: richard.sowden@aircanada.ca