A Standard for Equivalent Lateral Spacing Operations
– Parallel and Reduced Divergence Departures

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Outline

• **Background**
  – Departure Divergence
    • Radio Technical Commission for Aeronautics (RTCA) Task Force 5: *Reducing divergence criteria for parallel departures and for same-runway separation based on predictable and repeatable ground tracks of RNAV and RNP* (September 2009)

• **Current Divergence Standard**
  – Minimum requirements

• **Equivalent Lateral Spacing Operation (ELSO) Concept**
  – Reduced divergence formalism
  – Analysis of operational data

• **Equivalent Lateral Spacing Operation (ELSO) Application**
  – Parallel departures
  – Reduced divergence departures

• **Implementation Example**
  – The Atlanta Hartsfield-Jackson Atlanta International Airport (ATL)
    • RNAV Standard Instrument Departure (SID) Evolution Plan

• **Summary**
Departure Divergence
– Past Evolution and Potential Future Concepts –

Nonradar
Initial Separation of Simultaneous Departures
FAAO 7110.65 Section 6-2-1 Minima on Diverging Courses
3,500 feet or more
45 degrees or more

Radar
Radar Departures
Enabler: Improved surveillance precision
FAAO 7110.65 Section 5-3-8 Successive or Simultaneous Departures
2,500 feet or more
15 degrees or more

Radar & RNAV
RNAV Procedures
Enabler: Improved navigational precision

ADS-B & RNP
RNP Procedures
Enabler: Improved navigational & surveillance precision

Divergence reduction credits for:
- Navigation performance
- Runway spacing/stagger
- Surveillance performance
Current Divergence Standard (1/2)

FAAO 7110.65: 5-8-3.
Independent Parallel Departures (Radar Departures)
Minimum Requirements:
• Radar identification within 1 mile of the takeoff runway
• Centerlines/takeoff courses are separated by at least 2,500 ft
• Courses diverge by 15 degrees or more immediately after departure
Current Divergence Standard (2/2)

**FAAO 7110.65: 5-8-3.**

Independent Parallel Departures (Radar Departures)

**Minimum Requirements:**
- Radar identification within 1 mile of the takeoff runway
- Centerlines/takeoff courses are separated by at least 2,500 ft
- Courses diverge by 15 degrees or more immediately after departure

**Note:** The Minimum requirement for 15-degree divergence is independent of runway spacing
Equivalent Lateral Spacing Operation Concept: Example: Runway Spacing Credit

- More than 2,500 ft
- 10 NM
- 3 NM
- Equivalent Divergence Angle $\beta < 15$ degrees
- Maintains or exceeds lateral spacing between departure paths at current minima*

Notional. Nominal tracks only. Not to scale.
* Runway spacing 2,500 ft and 15-degree divergence.
Equivalent Lateral Spacing Operation Concept: Example: Navigational Capability Credit (1/2)

Departure Paths:
- Straight-out
- Diverging

Conventional operations

2,500 ft

15 deg

10 NM

less than 3 NM

Notional. Not to scale.
Equivalent Lateral Spacing Operation Concept: Example: Navigational Capability Credit (2/2)

Departure Paths:
- Straight-out
- Diverging

Conventional operations
RNAV operations

Equivalent Divergence Angle $\beta < 15$ degrees

Maintains or exceeds lateral spacing between departure paths at current minima*

* Runway spacing 2,500 ft and 15-degree divergence.
Equivalent Lateral Spacing Operation Concept: Equivalent Divergence Angle

Baseline spacing: \[ s(d) = r_{min} + d \tan(\alpha_{min} - \sigma_{DIV,C}(d)) - d \tan(\sigma_{STO,C}(d)) \]

Runway spacing: \[ r = s(d) + d \tan(\sigma_{STO,R}(d)) - (d + t) \tan(\beta - \sigma_{DIV,R}(d+t)) \]

Equivalent divergence angle: \[ \beta = \arctan\left\{ \frac{1}{d+t} \left( s(d) - r + d \tan(\sigma_{STO,R}(d)) \right) \right\} + \sigma_{DIV,R}(d+t) \]
Radar Track Data
Conventional Departure Operations

* Jet departures. 18,579 tracks (July 2008 and February 2010).
Radar Track Data
RNAV Departure Operations

* Jet departures. 10,166 tracks (February 2010).
Data Analysis

- **Example: Conventional Departures**
Analysis Results

- Conventional Departures
- RNAV Departures

- Departure Path Width
ELSO Standard: Equivalent Divergence Angle

- **Equivalent Divergence Angle**
  - Typical equivalent divergence angles:
    - 5 to 10 degrees
  - **Procedure design options not currently available**
    - Avoidance of noise sensitive areas
  - **Increased departure efficiency if reduced divergence enables diverging departure operations**
    - Increase in departure capacity
    - Reduction in departure delay

* Equivalent divergence angles for a runway stagger value of 2,000 ft.
Atlanta Implementation Example

- **ATL RNAV Evolution Proposal**
  - Number of diverging departure routes
    - Current: 3
    - Proposed: 4
  - 10-degree divergence
    - Runway 9L and 10
    - Runway 8R departures

- **Evaluation Results**
  - 10-degree divergence angles meet ELSO reduced divergence requirements
    - Provided SRMD support
  - Benefits to users estimated at $20M per year

*Example illustrates ATL’s RNAV Evolution Proposal for Triple departures in East Flow.*
Summary

- **Current Standard**
  - Single (fixed) minimum requirement of 15 degrees invariably inflates the lateral spacing between departure paths when runway spacing exceeds 2,500 feet or advanced course guidance is provided

- **ELSO Standard Concept**
  - Proposes reduced divergence angles while maintaining the lateral spacing between departure paths associated with minimum requirements of the current standard
    - Capitalizes on increased navigational precision and advantageous runway geometry
    - Suggests equivalent divergence angles that typically range from 5 to 10 degrees
  - Offers additional procedure design options
    - Better accommodate airspace and environmental constraints
    - Increase departure efficiency if application enables diverging departure operations

- **Implementation Example**
  - ELSO supports 10-deg divergence of ATL’s proposed RNAV SID evolution plan
  - RNAV SID implementation on schedule for Autumn 2011

- **Future Work**
  - Explore changes to the separation rule (FFAO 7110.65)
  - Extend concept into terminal and transitional airspace
  - Advance concept to ICAO Separation and Airspace Safety Panel
Thank you.

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