Simulator Evaluation of FMS Procedures for 2007 SDF CDAs

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Objectives

- Evaluate “Spacing Friendly” CDAs into Louisville.
  - Idle thrust from TOD to terminal entry.
  - Partial thrust descent legs in terminal area for speed flexibility.

- Evaluate candidate pilot procedures for flying the CDAs using FMS guidance.
  - FMS descent speed entry.
  - Speed intervention.

*Simulator evaluation conducted at NASA Langley in September of 2006*
LaRC Test Facility

Integration Flight Deck (IFD) Simulator

6-DOF High Fidelity Jet Transport simulation with Commercial FMC
VERTICAL NAVIGATION PLANNING INFORMATION

Arrival must be flown using FMS LNAV and VNAV guidance.

ARRIVAL


PILOT NOTES

1. KSDF ATIS will indicate if CDA procedures are in effect for UPS B757/767 arrivals.
2. Load the CDA17R or CDA35L with the filed transition and the corresponding ILS. Close the discontinuity between the arrival and the ILS final approach fix.
3. Verify speed/altitude constraints from the FMS match the Jeppesen CDA chart.
4. Set FMS descent speed to .82/335.
5. MCP altitude window should be set to lowest assigned ATC altitude clearance. The 3800' altitude at the TRN17/35 waypoints is not an ATC restriction—it initiates the speed slowdown.
6. Enter any ATC speed or route changes in the FMS and use power or speed brakes to re-acquire the VNAV path. Flight level change or vertical speed should not be required.
7. For best VNAV path performance maintain speed close to commanded speed.
8. Select flaps to 1 no later than FLP17/FLP35 and flaps to 5 prior to TRN17/TRN35.
9. Arm APPROACH after receiving ATC clearance for the ILS.
10. After glide slope capture, set speed window to match CDA profile.
11. No later than 1 mile prior to final approach fix, select gear down and flaps 20.

ATC CLEARANCE INFORMATION

1. The filed ATC clearance is the CHERI2 arrival and ends at the IIU VOR.
2. Clearance from Indianapolis Center will be a routing to CHERI and pilot’s discretion to 11,000 feet.
3. Indianapolis will switch the flight to Louisville Approach in the vicinity of SACKO intersection.
4. Louisville Approach will give clearance for the CDA17R/35L arrival and pilot’s discretion to 3,000 feet.
5. If clearance for the CDA and lower altitude is not received from Louisville Approach prior to CHERI, proceed via the filed routing to IIU VOR and maintain last assigned altitude.

2004 CDA35L Vertical Profile

B767 vertical profiles from 2004 flight trials

Altitude, feet

Flying distance to runway, nmi

CRDNL 170/2400

INT35 180/3000

TRN35 ---/3800A

CRDNL 170/2400
TRACON Profile - Hard Altitude Constraints

Distance to runway, nmi

Altitude, ft

Indicated airspeed (kts), Throttle (deg)

Too much throttle transient
TRACON Profile – “AT or Above” 4400’ Constraint

Better, but still too much
TRACON Profile – “At or Above” Constraints

Better still, but questionable G/S capture
Best we can do, however, requires altitude constraint below ILS IAF
UPS 2007 CDA Arrival Chart (North Arrivals)
UPS 2007 CDA Arrival Chart (South Arrivals)
Speed Intervention – “At or Above” Constraints

Worst case with no pilot correction to avoid level off
FMS Speed Change During Idle Descent

Distance to runway, nmi

Altitude, ft

Airspeed (kts), Throttle (deg), Speedbrake (deg)

Altitude
VNAV PATH
Waypoints
Indicated airspeed
Speed target
Throttle
Speedbrake
757 Idle Descent Variations With Speed

Slower speed results in new path below current path

Slower speed results in new path above current path
Speed Recalculation After Constraint

No change to vertical path with FMS speed entry along a fixed FPA leg between constrained waypoints.
Summary

- “Spacing friendly” CDAs were designed and tested using the Langley IFD cockpit simulator.
- Use of “At or Above” altitude constraints reduced the throttle transients.
- Changes to FMS descent speed were practical during early portions of the descent.
  - Change to FMS descent path not always intuitive.
- Speed intervention also practical.
  - Pilot must manually manage thrust to maintain path.
- UPS has initiated flight trials of CDAs.
- LaRC is currently testing CDAs with spacing guidance.