CONTINUOUS DESCENT OPERATIONS (CDO) – Part 1
Basic Theory

ICAO Doc 9931
Learning Objectives

By the end of this presentation you should understand:

- What is a CDO
- What ICAO Manual covers CDO
- Differences between Closed and Open path CDO
- CDO Design possibilities
- CDO Design Considerations
- CDO Implementation Process
GENERAL OVERVIEW

✈ CDO should always be considered by airspace designers and procedure designers especially when implementing new Arrivals (STAR) and Approaches

✈ CDO: Where aircraft descends continuously, employs minimum engine thrust in a low drag configuration

✈ Usable by 85% of the aircraft, 85% of the time
GENERAL OVERVIEW

Conventional Step-down
- Top of Descent
- Level flight segments

Continuous Descent Operations
- Top of Descent
- Approach Segment
- Optimized Segment(s)
OPTIMUM VERTICAL PATH

The optimum vertical path angle will vary depending on:

- type of aircraft
- its actual weight
- the wind
- air temperature
- atmospheric pressure
- icing conditions
- and other dynamic considerations

The maximum benefit is achieved by keeping the aircraft as high as possible until it reaches the optimum descent point determined by the onboard flight management computer.
Why CDO beneficial?

Continuous Descent Approach profiles

Establish on the Instrument Landing System

Potential for avoidable unnecessarily extended level segment at low level

'Conventional' approach Profiles

Area of noise benefit

Runway

Picture Source: Alan Melrose (Eurocontrol)
OPTIMUM VERTICAL PATH

Flight tracks before CDO

Flight tracks after CDO
**BENEFITS**

An optimum CDO starts from the Top of Descent:

Reducing-
- segments of level flight
- noise
- fuel burn
- emissions
- ATC/Pilot communication and workload

While Increasing:
- predictability to ATC/Pilots
- flight stability
- consistency flight path
BENEFITS

Importance of an Idle Descent

- Idle Descent
- 640 lbs/hr/engine
- 1280 lbs/hr
- 3.2 gal/min
Level-offs Use 4 to 5 Times More Fuel Than a Idle Descent!

- Level, 210 kt, flaps up: x 3.7 = 2.38
- Level, 180 kt, flaps 5: x 4.0 = 2.52
- Level, 170 kt flaps 10: x 4.4 = 2.84
- Level, 160 kt, flaps: x 5.5 = 3.49
Continuous Descent Operations

- Continuous Descent Operations (CDO) Manual (ICAO Doc 9931)
- First Edition published 2010
- CDO is an aircraft operating technique
- enabled by airspace design, procedure design and
- facilitated by ATC
- in which an arriving aircraft descends continuously, to the greatest extent possible,
- using minimum engine thrust and low drag.
Continuous Descent Operations

Continuous Descent Operations (CDO) Manual, ICAO Doc 9931

Provides background for:
- Air Navigation Service Providers
- Aircraft Operators
- Airport Operators
- Aviation Regulators
Continuous Descent Operations

CDO Manual ICAO Doc 9931

Key objectives for the manual are to improve:

- Overall management of traffic and airspace in order to enable uninterrupted continuous descents without disrupting departures.

- Understanding of continuous descent profiles and,

- Understanding and harmonization of associated terminology.
CDO

Accurate planning for an optimum descent path is facilitated by the pilot and/or the FMS knowing the flight distance to the runway and the level above the runway at which the CDO is to be initiated.

Thus a CDO requires planning and communication between the pilot and the air traffic controller.
A CDO design is integrated within the airspace concept and must balance the needs of departing aircraft with the CDO arrival aircraft (CDO vs CCO)
DESIGN OF CDO

There are currently two methods for the design of CDO procedures based on “laterally fixed”

These two design methodologies are identified as “closed path” and “open path” designs.
Different Types of Arrivals

Closed Path

Open Path

Enroute ATS Route Structure

Procedure

ATS Route

Linked route
• known distance

procedure

ATS Route

Linked route
• known distance

procedure

Tactical vectors provided by ATC
• unknown distance
• DTG estimate
Open Path Arrival Designs

**Vectored CDO**

ATC issues pilot “Distance-To-Go” estimate

End of preplanned route and beginning of radar vectors with issuance of estimated distance to fly.
Open Path Arrival Designs

Point Merge

- Merge point
- Envelope of possible paths
- Integrated sequence
- Arrival flow
- Sequencing legs (at iso-distance from the merge point)

Path Stretching

Path 1: +1 min
Path 2: +2 min
Path 3: +3 min
Closed Path CDO Design

- Save fuel 125-1400 lbs
- Up to 40% less noise
- Reduced radio transmissions
- Lower pilot workload / improved predictability
- Reduced hearback/readback errors
**HNL CDO Example**

- **KAENA, KLANI, REEEF CDO**
  - Fully integrated/linked to approach.
  - Descend via from cruise flight levels.
  - Initial Fuel Savings 300-1200+ pounds per flight.
CDO Integration

Integrating RNAV, RNP, & Conventional Capabilities

Equidistant TOD estimates

Conventional Arrivals

RNAV Arrivals

HAIKU RNAV CDO STAR links with RNP-AR RWY 02 and ILS RWY 02

PBN Airspace Concept Workshop
CDO Integration

Integrating RNAV, RNP, & Conventional Capabilities
CDO Implementation Process

CDO Implementation Road Map

1. Initial proposal to examine CDO
2. Informal preliminary consultations
3. Prepare outline case
4. Top management commitment
5. Establish CEM group (or place on suitable agenda)

Prepare

Plan

Implement

Review

1. Simulate, trial, assess and validate
2. Consider options and jointly agree preferred implementation method
3. Design CDA implementation method
4. Strategic planning including defining Roles and Responsibilities and jointly agreeing implementation, development and reporting plan (KPIs)
5. Establish CEM group (or place on suitable agenda)

Public consultation on proposals

Prepare Plan Implement

Periodic review

Using parallel processing where appropriate

N.B.: This is NOT meant to be a blueprint and may require adjustment to suit differing local requirements.

PBN Airspace Concept Workshop
QUESTIONS?
Practical Example

Development, design, and flight test evaluation of a continuous descent approach procedure for nighttime operation at Louisville International Airport
Averge Engine N1 to SDF 35L

Distance to Runway, nm

Average N1, %

- ZARDA
- PENTO
- SACKO
- CHERI
- FLP35
- TRN35
- CRD27
- CRDNL
- RWY35L

B767 CDA on Sep 22
B757 CDA on Sep 15
B767 STD on Sep 08
B757 STD on Sep 28
Fuel Consumption to SDF 35L

Distance to Runway, nm

Fuel Consumption, lb

- B767 CDA on Sep 22
- B757 CDA on Sep 15
- B767 STD on Sep 08
- B757 STD on Sep 28
Fuel Consumed over last 180NM to runway 35L

All aircraft at cruise altitude 180 nm from runway. Values corrected for wind and merge point.
Figure 9-9: Representative cumulative noise contours for conventional approach
Figure 9-8 Representative cumulative noise contours for CDA
Condensation trails in the air are increasing, which demands improved systems for air traffic control.
Continuous descent approach >
< Minimum ILS joining height 2500ft. (2000ft LGW)
< 3 deg.
Bottom of stack approx. 6000ft >
Holding stack >

Continuous descent operation = CD
FAP

CD approach
Normal approach

Runway

Area of maximum noise benefit
11–12 km

Continuous descent approaches
CDA: Least possible thrust, highest possible attitude

Today’s practice: 6 to 10 step downs

Runway

Area of noise benefit

Thrust

Thrust