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AN/495



Continuous Climb Operations (CCO) Manual

Approved by the Secretary General
and published under his authority

First Edition — 2013

International Civil Aviation Organization

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FOREWORD

The purpose of this manual is to provide guidance on continuous climb operations (CCO) and to harmonize its development and implementation. The climb phase uses a significant proportion of the total flight fuel; introducing efficiencies in this phase could provide significant economic and environmental benefits in terms of both noise and emissions.

To achieve this, airspace design, instrument flight procedure design and air traffic control (ATC) techniques should all be employed in a cohesive manner. This will facilitate the ability of flight crews to use in-flight techniques to optimize the efficiency of the climb operation through a coherently developed airspace concept. This will be achieved while maintaining air traffic management (ATM) capacity and, as a result of the design taking into account actual ranges of flight profiles, remove or at least reduce the potential for conflict between traffic flows thereby increasing safety.

The implementation guidance in this manual is intended to support collaboration among the following stakeholders involved in implementing continuous climb operations:

- a) air navigation service providers (ANSP), including:
 - 1) policy/decision makers;
 - 2) airspace designers;
 - 3) instrument procedure designers; and
 - 4) operational ATC staff;
- b) aircraft operators:
 - 1) policy/decision makers;
 - 2) pilots; and
 - 3) technical (flight management system (FMS) expertise) staff;
- c) airport operators including:
 - 1) operations department; and
 - 2) environment department;
- d) aviation regulators.

The CCO manual forms one part of a package of related documents where the overarching document is the *Airspace Concept Manual* (Doc 9992) with the Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO) manuals forming examples of the application of the airspace concept.

Future developments

Comments and recommendations on this manual would be appreciated from all parties involved in the development, implementation and operation of CCO. These comments should be addressed to:

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EXECUTIVE SUMMARY

Continuous climb operations (CCO) is an aircraft operating technique enabled by airspace design, instrument procedure design and facilitation by ATC, allowing for the execution of a flight profile optimized to the performance of the aircraft. CCO enables the aircraft to attain initial cruise flight level at optimum airspeed and engine thrust settings set throughout the climb, thereby reducing total fuel burn and emissions. Ideally, the departure design is such that arriving traffic is also able to descend based on an optimum descent profile. Where the departure and arrival flows cannot be designed independently, there will need to be a compromise between the needs of the departure and arrival flow optimization; this compromise should be reached collaboratively.

This manual contains guidance material on the airspace design, instrument flight procedures, ATC facilitation and flight techniques necessary to enable CCO. It therefore provides background and implementation guidance for:

- a) air navigation service providers, including both terminal and en-route facilities;
- b) aircraft operators/pilots;
- c) airport operators; and
- d) aviation regulators.

The key objectives of this manual are to improve the:

- a) overall management of traffic and airspace in order to enable efficient climb profiles, minimizing interference between departing and arriving traffic;
- b) understanding of requirements for continuous climb profiles; and
- c) understanding and harmonization of associated terminology.

CCO is one of several tools available to aircraft operators and ANSPs that, through collaboration between stakeholders, will make it possible to increase efficiency, flight predictability and airspace capacity, while reducing fuel burn, emissions and controller-pilot communications, thereby maintaining safety. Over the years, different airspace models have been developed to facilitate efficient terminal operations, and several methods have been adopted to optimize the terminal airspace design to provide a balanced approach towards achieving profiles close to the ideal fuel-efficient and environmentally friendly procedures, while maximizing the capacity of an airport and its surrounding airspace.

Starting with the design of the standard instrument departure (SID), an optimum continuous climb can be undertaken from take-off to cruise, including the noise abatement departure procedure, reducing both controller-pilot communications and segments of level flight. Such a profile should also provide a reduction in noise, fuel burn and emissions, while increasing flight stability and the predictability of the flight path to both controllers and flight crews.

Standard instrument departure/standard instrument arrival (SID/STAR) procedures should be designed in concert with one another to achieve balanced flight path profiles thereby ensuring that the profiles meet the needs of both the ATC and operators to the greatest extent possible. The procedures need to be presented in an unambiguous manner, ensuring the ATC and flight crews have a common understanding of requirements and the resulting flight

profiles. To achieve this, the instrument procedure designer needs to understand the flight characteristics, limitations and capabilities of the range of aircraft expected to perform CCO at the subject airport, as well as the characteristics of the airspace and routes where CCO will be used. For airport operators and environmental entities, it is important to understand the extent and limitations of environmental benefits, aircraft performance and airspace when proposing CCO.

The climb is the phase of operations that uses the highest rate of fuel during a flight. Considering the growing concerns about the environment and particularly climate change and taking into account the high cost of fuel, collaborating to facilitate CCO is essential for all operational stakeholders.

It is of paramount importance that safety be maintained during all phases of flight — nothing in this guidance shall take precedence over the requirement for the safe operation and control of aircraft at all times. To avoid doubt, all recommendations are to be read as being “subject to the requirements of safety”.

Before any CCO-based procedure trials or operations commence, the proposed implementation needs to be the subject of a local safety assessment.

REFERENCES

Note.— Documents referenced in this manual or affected by continuous climb operations.

ICAO documents

Annex 4 — *Aeronautical Charts*
Annex 6 — *Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes*
Annex 6 — *Operation of Aircraft, Part II — International General Aviation — Aeroplanes*
Annex 8 — *Airworthiness of Aircraft*
Annex 10 — *Aeronautical Telecommunications, Volume I — Radio Navigation Aids*
Annex 11 — *Air Traffic Services*
Annex 15 — *Aeronautical Information Services*
Annex 17 — *Security — Safeguarding International Civil Aviation Against Acts of Unlawful Interference*

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) (Doc 4444)
Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS) (Doc 8168)
 Volume I — *Flight Procedures*
 Volume II — *Construction of Visual and Instrument Flight Procedures*

Regional Supplementary Procedures (Doc 7030)
Manual on Testing of Radio Navigation Aids (Doc 8071)
Air Traffic Services Planning Manual (Doc 9426)
Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689)
Global Navigation Satellite System (GNSS) Manual (Doc 9849)
Safety Management Manual (SMM) (Doc 9859)

Circular 317, Effect of PANS-OPS Noise Abatement Departure Procedures on Noise and Gaseous Emissions

European Organisation for Civil Aviation Equipment (EUROCAE) documents

Minimum Operational Performance Specifications for Airborne GPS Receiving Equipment used for Supplemental Means of Navigation (ED-72A)
MASPS Required Navigation Performance for Area Navigation (RNAV) (ED-75B)
Standards for Processing Aeronautical Data (ED-76)
Standards for Aeronautical Information (ED-77)

RTCA, Inc. documents

Standards for Processing Aeronautical Data (DO-200A)
Standards for Aeronautical Information (DO-201A)
Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment using the Global Positioning System (DO-208)
Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation (DO-236B)

Aeronautical Radio, Inc. (ARINC) 424 documents

ARINC 424-() Navigation System Database Specification

Document number changes

The bundling of Federal Aviation Administration (FAA) Advisory Circulars (ACs) or European Aviation Safety Agency (EASA) Acceptable Means of Compliance (AMCs) may result in document number changes, e.g. AC 20-138B supersedes AC 20-129/AC 20-130A/AC 20-138A/AC 25-4). Similarly, some technical standard orders (TSOs) have been superseded by newer publications, e.g. FAA TSO-C129() superseded by TSO-C196. In these cases, the original document number available at the time of issue has been retained.

ACRONYMS

ADS-B	Automatic dependent surveillance — Broadcast
ANSP	Air navigation service provider
ATC	Air traffic control
ATM	Air traffic management
ATS	Air traffic services
CCO	Continuous climb operations
CDO	Continuous descent operations
EUROCAE	European Organisation for Civil Aviation Equipment
FMC	Flight management computer
FTS	Fast time simulation
FMS	Flight management system
ICAO	International Civil Aviation Organization
LNAV	Lateral navigation
MSL	Mean sea level
NADP	Noise abatement departure procedure
NADP 1	Noise abatement departure procedure 1 — an example noise abatement procedure given in ICAO Doc 8168
NADP 2	Noise abatement departure procedure 2 — an example noise abatement procedure given in ICAO Doc 8168
NM	Nautical mile
PBN	Performance-based navigation
PSR	Primary surveillance radar
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
RF	Radius to fix
RTS	Real time simulation
SID	Standard instrument departure
SSR	Secondary surveillance radar
STAR	Standard instrument arrival
TA	Transition altitude
TF	Track to fix
TL	Transition level
TOC	Top of climb
TOR	Terms of reference
VM	Heading to manual termination
VNAV	Vertical navigation

EXPLANATION OF TERMS

Area navigation (RNAV). A method of navigation which permits aircraft operations on any desired flight path within the coverage of ground- or spaced-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Note.— Area navigation includes performance-based navigation as well as other operations that do not meet the definition of performance-based navigation.

ATS surveillance service. A term used to indicate a service provided directly by means of an ATS surveillance system.

ATS surveillance system. A generic term meaning variously, ADS-B, PSR, SSR or any comparable ground-based system that enables the identification of aircraft.

Note.— A comparable ground-based system is one that has been demonstrated, by comparative assessment or other methodology, to have a level of safety and performance equal to or better than monopulse SSR.

Continuous Climb Operation (CCO). An operation, enabled by airspace design, procedure design and ATC, in which a departing aircraft climbs without interruption, to the greatest possible extent, by employing optimum climb engine thrust, at climb speeds until reaching the cruise flight level.

Continuous Descent Operation (CDO). An operation, enabled by airspace design, procedure design and ATC facilitation, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach fix /final approach point.

Note 1.— An optimum CDO starts from the top of descent and uses descent profiles that reduce segments of level flight, noise, fuel burn, emissions and controller/pilot communications, while increasing predictability to pilots and controllers and flight stability.

Note 2.— A CDO initiated from the highest possible level in the en-route or arrival phase of flight will achieve the maximum reduction in fuel burn, noise and emissions.

Level. A generic term relating to the vertical position of an aircraft in flight and meaning variously, height, altitude or flight level.

Mixed navigation environment. An environment where different navigation specifications may be applied within the same airspace (e.g. RNAV 1 routes and conventional navigation operations in the same airspace) or where operations using conventional navigation are allowed in the same airspace with RNAV or RNP applications.

Noise Abatement Departure Procedure 1 (NADP 1). An example departure procedure alleviating noise close to airport (see PANS-OPS (Doc 8168), Volume I).

Noise Abatement Departure Procedure 2 (NADP 2). An example departure procedure alleviating noise distant from the airport (see PANS-OPS (Doc 8168), Volume I).

Navigation aid (navaid) infrastructure. Space-based and/or ground-based navigation aids available to meet the requirements of the navigation specification.

Navigation application. The application of a navigation specification and the supporting navaid infrastructure, to routes, procedures, and/or defined airspace volume, in accordance with the intended airspace concept.

Note.— The navigation application is one element, along with communication, surveillance and ATM procedures which meet the strategic objectives in a defined airspace concept.

Navigation function. The detailed capability of the navigation system (such as the execution of leg transitions, parallel offset capabilities, holding patterns, navigation databases) required to meet the airspace concept.

Note.— Navigational functional requirements are one of the drivers for the selection of a particular navigation specification. Navigation functionalities (functional requirements) for each navigation specification can be found in the Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, Parts B and C.

Navigation specification. A set of aircraft and flight crew requirements needed to support performance-based navigation operations within a defined airspace. There are two kinds of navigation specifications:

Required navigation performance (RNP) specification. A navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4, RNP APCH.

Area navigation (RNAV) specification. A navigation specification based on area navigation that does not include the requirement for performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1.

Note 1. — The Performance-based Navigation (PBN) Manual (Doc 9613), Volume II, contains detailed guidance on navigation specifications.

Note 2.— The term RNP, previously defined as “a statement of the navigation performance necessary for operation within a defined airspace”, has been removed (...) as the concept of RNP has been overtaken by the concept of PBN. The term RNP (...) is now solely used in the context of navigation specifications that require performance monitoring and alerting, e.g. RNP 4 refers to the aircraft and operating requirements, including a 4 NM lateral performance with on-board performance monitoring and alerting that are detailed in the PBN Manual (Doc 9613).

Performance-based navigation (PBN). Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

Note.— Performance requirements are expressed in navigation specifications (RNAV specification, RNP specification) in terms of accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept.

Procedural control. Air traffic control service provided by using information derived from sources other than an ATS surveillance system.

RNAV operations. Aircraft operations using area navigation for RNAV applications.

RNAV system. A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. An RNAV system may be included as part of a flight management system (FMS).

RNP operations. Aircraft operations using an RNP system for RNP navigation applications. An RNP system may be included as part of a flight management system (FMS).

RNP route. An ATS route established for the use of aircraft adhering to a prescribed RNP navigation specification.

RNP system. An area navigation system which supports on-board performance monitoring and alerting.

Standard instrument arrival (STAR). A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.

Standard instrument departure (SID). A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.

Part A

CONTINUOUS CLIMB OPERATIONS OVERVIEW

