



连续下降与连续爬升运行在 中国的应用

CDO and CCO Implementation in China

中国民用航空局空中交通管理局
Air Traffic Management Bureau, CAAC

2020.10.22



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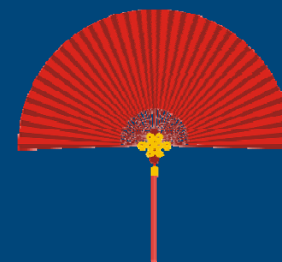
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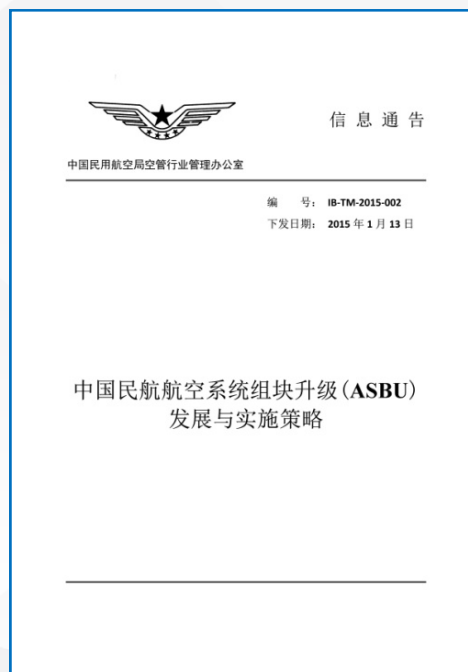
01

工作背景

Working Background



工作背景



ICAO

全球空中航行计划
(Global Air Navigation Plan)
亚太无缝空管计划
(Asia Pacific Seamless ATM
Plan)

CAAC

中国民航航空系统组块升级
(ASBU)发展与实施策略
CAAC ASBU Development and
Implementation Strategy



02

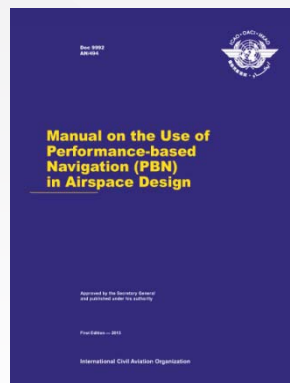
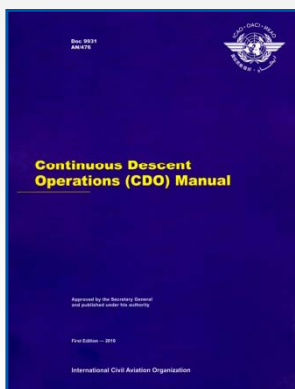
技术研究

Technical Research

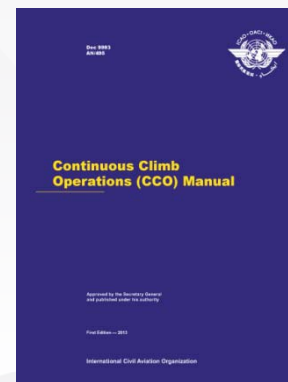


规范标准 Standards ICAO Doc 9992/Doc 9613
PBN空域设计手册/PBN手册

ICAO Doc 9931
CDO手册



ICAO Doc 9993
CCO手册



CDO规划与实施
CDO Plan and Implementation

CCO规划与实施
CCO Plan and Implementation



>>> 概念研究 Concepts Research

CDO
&
CCO



》》 CDO研究 CDO Research

阶梯式下降运行
Step-down

下降顶点TOD

Level flight segment
水平飞航段

连续下降运行
CDO

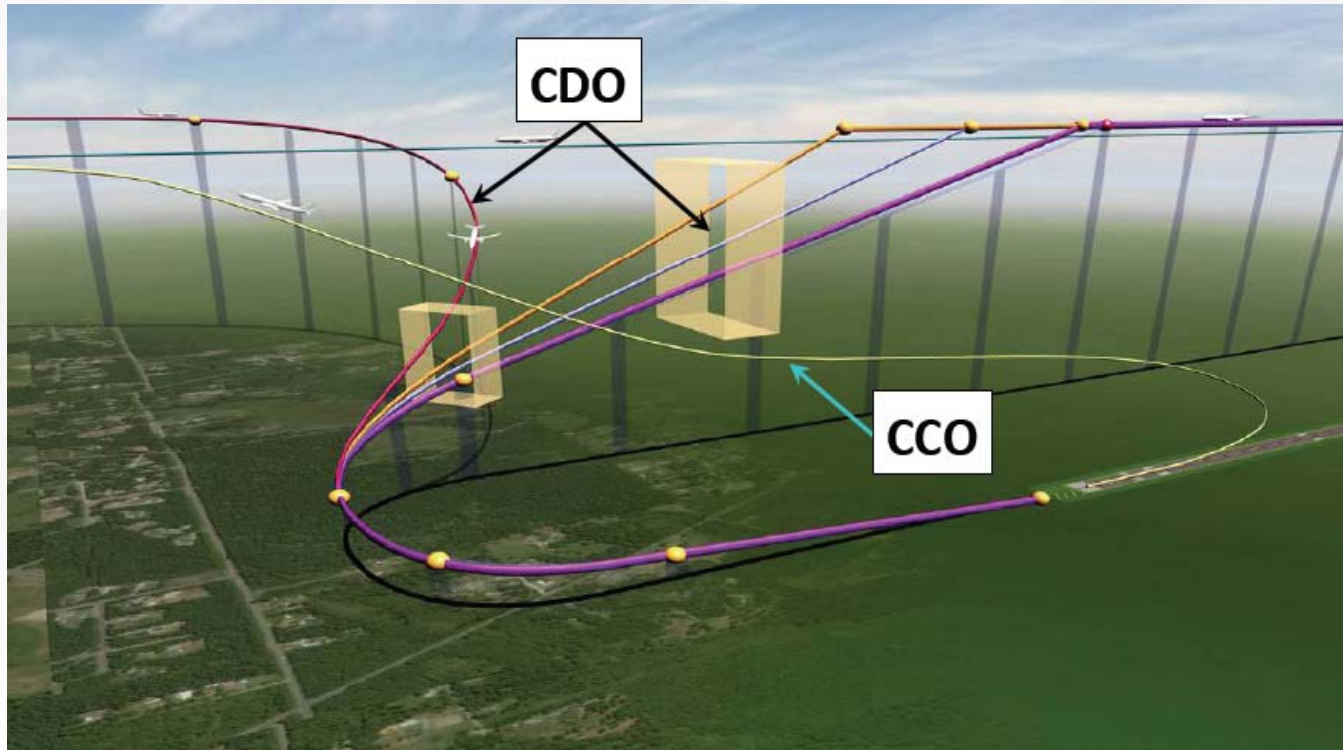
下降顶点TOD

Approach
进近航段

优化的下降剖面
Optimal descent profile



CCO研究 CCO Research



》》》 效益 Benefits

提升飞行安全 Safety Improvement

航空器在降落、起飞阶段，减少了改平频次和出错概率，提高了飞行稳定性与连贯性，从而提升安全性。

To reduce the level flight segment of aircraft during arrival and departure, so as to enhance the flying stability and continuity for a safer performance

更少的机舱操作和检查校对，大幅降低陆空通话和操作互检频次，从而降低工作负荷。

Less cockpit operation and checking for pilots; less air-ground communication and cross-checking for ATCs

降低机组负荷 Release Cockpit Workload

促进绿色航行 Green operation Improvement

有效节省飞行时间、燃油消耗和二氧化碳等温室气体排放数量，还可以部分缓解噪音的影响

To save flying time, decrease oil consumption and greenhouse gas emissions; moreover, partly reduce flying noise

航班可以较长时间保持云层上方巡航飞行，缩短通过结冰区、湍流区等气象条件较为恶劣空域的时间，减少旅客压耳感，提升乘机舒适度。

Longer time to fly above cloud and less time to fly through turbulence or icing area during arrival and departure so as to improve the comfort for passengers

提升乘机舒适度 Comfort Improvement



>>> 特殊性 Specialties



有别传统理念 Different from current concepts

实施CDO与CCO运行的飞行员应当严格遵守飞行程序的各项要求限制（尤其是高度限制），除非管制员明确取消相关程序限制

Aircraft on CDO/CCO need to strictly follow all the restrictions on STARs/SIDs unless ATC cancels it.



有别传统运行 Different from conventional ATC control

管制员发布CDO 运行许可后，应当主动告知飞行员“下降报”。飞行员应当根据航空器性能计算出适宜的下降顶点（TOD），并在下降顶点前至少1 分钟主动向管制员申请下降。

If ATC release the permission for a flight to conduct CDO, the pilot shall apply for descent 1 minute before the calculated TOD



有别传统操作 Different from traditional cockpit operation

为确保遵守所有CDO/CCO 程序限制，飞行员应当尽量利用管理模式（空客飞机）或垂直导航模式（波音飞机）进行下降或爬升。

In order to conduct a CDO/CCO, pilot shall utilizing the management mode (Airbus) or VNAV mode (Boeing) of FMGS/FMS



03

应用步骤

Implementation Steps



地区选择标准 Considerations

进离场分离运行，且骨干衔接航路基本实现单向运行。

Airports with arrival and departure routes fully or partly separated.

管制员与飞行员熟练掌握基于性能导航 (PBN) 运行，接受新技术能力较强。

ATC and pilots are familiar with PBN operations and open to new concept.

试运行时间段具备一定的航班量，保证运行效益，具有参考借鉴意义。

Enough traffic during the trial operation period

空域成熟
Developed
airspace

地形优势
Topographical
advantage

经验丰富
Experienced

发展需求
Development
Request

应用价值
Application
Benefits

以平原为主，除小范围山区外，受地形与障碍物限制较小。
Plain area with limited terrain is favorable.

随着城市与机场的发展，节能减排降噪需求日益突出。
Mandatory request of the city government to reduce noise around airport



时间选择标准 Trial Period Selection



应用步骤 Implementation Steps

第一阶段 First Phase

试点应用阶段 Trial

选择具有代表性的地区
率先进行试点应用，形
成以点带面的效应。

Initiated trial
operations in several
selected airports

第二阶段 Second Phase

扩大应用阶段 Expansion

在原有试点基础上，扩大
并建全全国各地区
CDO/CCO代表性机场。

Based on experience
gained, increased the
number of trial airports

第三阶段 Third Phase

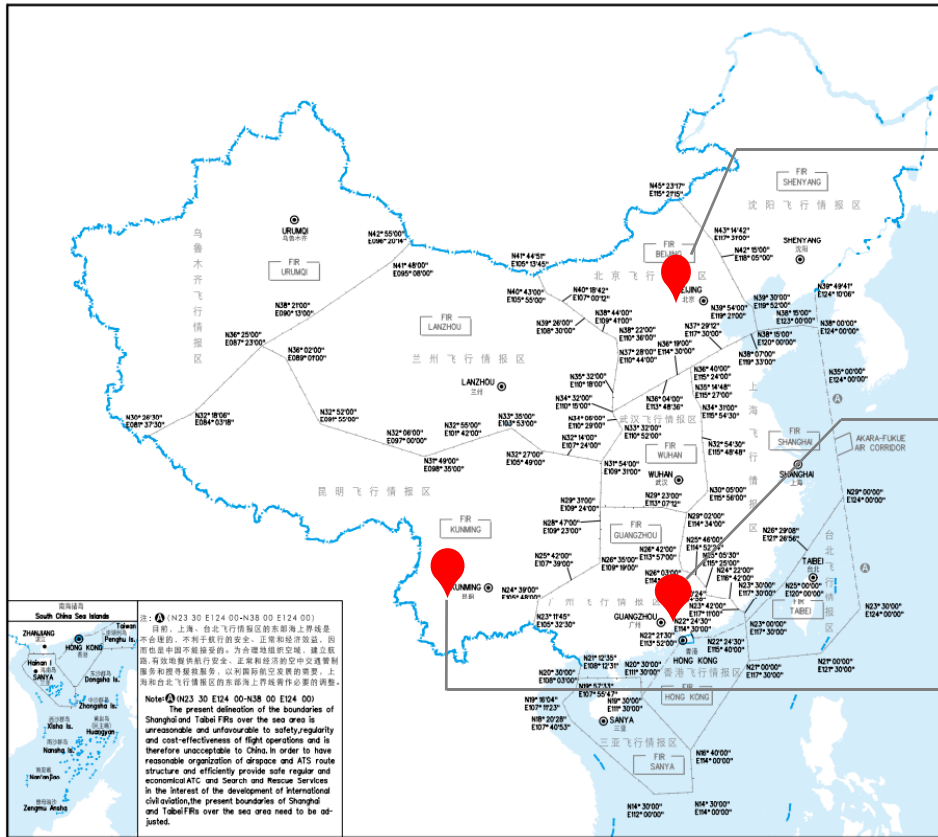
全面推广阶段 Overall Implementation

以全国各地区
CDO/CCO代表性机
场辐射效应，开展全
国推广应用。

To implement all
over China



▶▶▶ 试点应用阶段 The Trial Phase



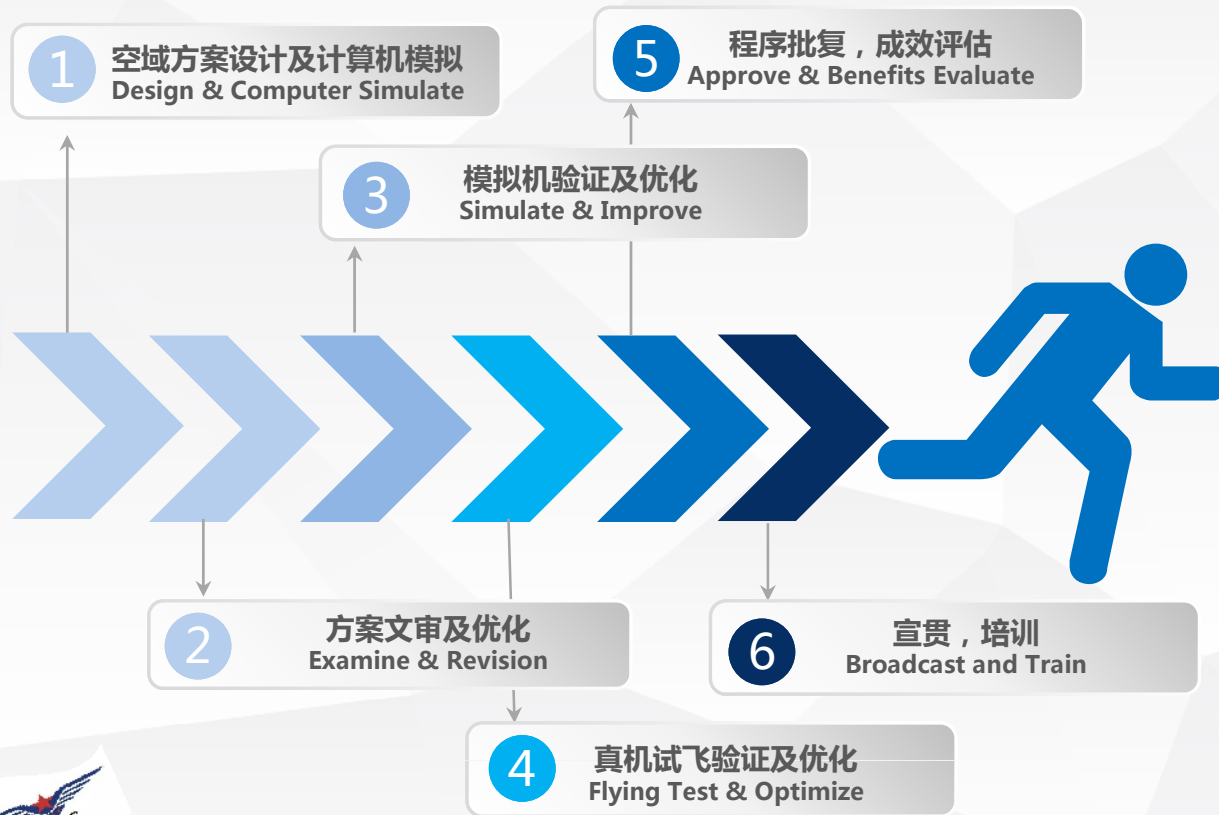
2017年，首个将CDO与CCO技术推广到区域阶段的机场
In 2017, the Beijing Intl. Capital Airport, the first airport implements CDO & CCO within ACC and APP.

2016年，中国首个应用CDO与CCO机场
In 2016, the Guangzhou Baiyun Intl. airport, the first airport implements CDO & CCO in China.

2018年，首个应用CDO与CCO的高原机场
In 2018, Kunming Changshui Intl. airport, the first high-altitude airport implements CDO & CCO.



▶▶▶ 试点应用阶段 The Trial Phase



通力合作促成功

Approaching Success through Joint Efforts

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广州/白云

GUANGZHOU/baiyun

广州白云机场连续下降运行与连续爬升运行试点工作指导材料

Guidance for Continuous Descent Operation (CDO) and Continuous Climb Operation (CCO) Trial at Guangzhou Baiyun Airport

一、概述

1. 根据国际民航组织《全球空中航行规划》和民航局《中国民用航空系统升级换代 (ASBU) 发展及实施策略》相关要求, 为稳步提升航空器下降与爬升剖面的灵活高效, 确保连续下降运行 (CDO) 与连续爬升运行 (CCO) 在广州白云机场试点实施的安全顺畅, 并为后续应用推广工作奠定基础, 制定本指导材料。

2. 连续下降运行 (CDO), 是在空域与飞行程序优化设计的基础上, 结合适宜的空中交通管制措施与飞行操作方法等实现的一种运行。运行期间, 进场航空器在到达最后进近定位点/最后进近点之前, 通过利用最小发动机的推力, 尽量以一种低阻力构型进行连续下降。

注: 理想情况下, 航空器在进近或进场阶段尽可能从最高的高度开始连续下降运行, 可以最大限度地减少平飞航段, 燃油消耗, 噪音污染, 废气排放和管制员/飞行员通话, 同时提升飞行的稳定性; 实际运行中, 受交通流密度、天气条件以及其他飞行活动等影响, 管制员可能在实施过程中进行技术性干预, 包括速度调整和雷达引导等, 对进场航空器进行排序及间隔调配。航空器驾驶员根据适当的空管指令, 并依照相关标准仪表进场程序, 实施阶段性或局部性的连续下降仍可获得可观的运行效益。

Introduction

1. In accordance with ICAO Global Air Navigation Plan and CAAC Civil Aviation System Block Upgrade Strategy, this guidance is developed with the intention to improve flexibility and efficiency of aircraft descent and climb profile, to ensure a safe and smooth trial of CDO and CCO at Guangzhou Baiyun Airport, and to lay solid foundation for further implementation.

2. Continuous descent operation (CDO) is an operation, enabled by airspace and procedure design, ATC facilitation and flight technique, 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: Ideally, a CDO initiated from the highest possible level in the enroute or arrival phases of flight will to the largest extent reduce segments of level flight, fuel burn, noise, emissions and controller-pilot communications, while increasing flight stability. In practice, due to traffic density, weather condition and other flying activity, air traffic controllers may conduct tactical intervention during a CDO, including speed adjustment, radar vectoring and etc. for the purpose of sequencing arrival traffic or ensuring safe separation between aircraft. However, while a fully optimal CDO may not be possible, a CDO carried out by pilot following appropriate ATC instructions and within



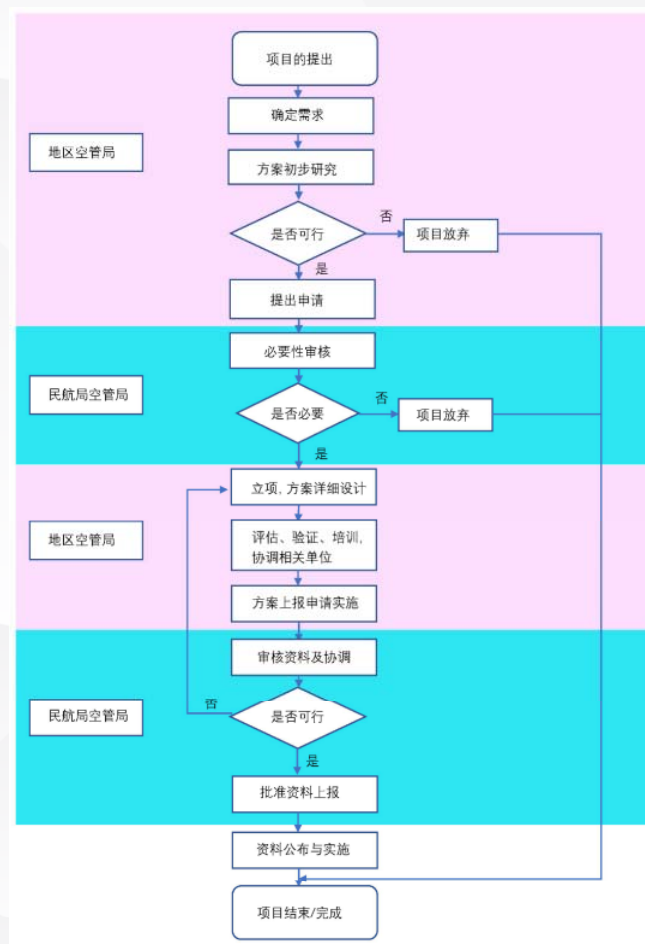
▶▶▶ 试点应用阶段 The Trial Phase



完善工作程序 Establish working process

为规范后续CDO/CCO应用规划和实施流程，我们研究制定了CDO/CCO规划与应用工作程序。

To facilitate successful implementation of CDO/CCO in more airports, a standardized working process has been established within ATMB.

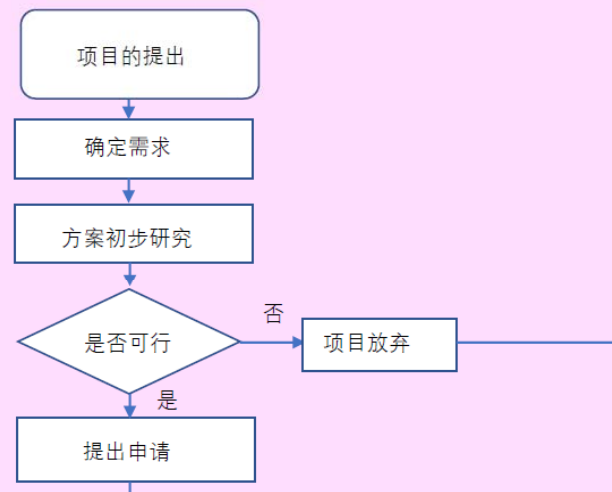


完善工作程序 Establish working process



1、项目提出 Programme Proposal

地区空管局



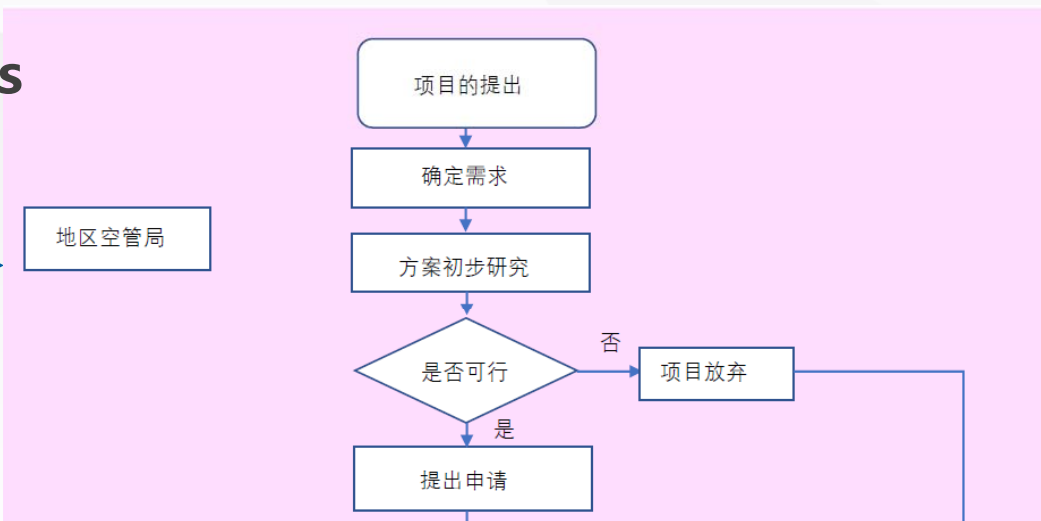
- 1、基本原则和具体目标 Principals & Specific targets
- 2、对现状的分析以及对近远期的预测 Baseline analysis and future estimation
- 3、其他空域用户情况 Other airspace users consultation
- 4、必要性分析 Necessity Analysis



完善工作程序 Establish working process



2、初步研究 Preliminary Research



地区空管局

- 1、CDO/CCO应用范围 Application area
- 2、概念设计方案 Concept design
- 3、方案可行性分析 Feasibility analysis
- 4、服务方式和责任单位 ATC service & Units of responsibility
- 5、实施安排 Implementation arrangements
- 6、其他事项 Other issues.

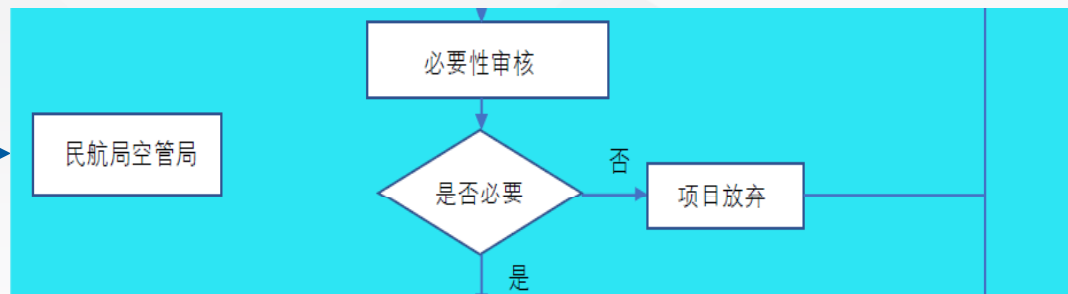


完善工作程序 Establish working process



3、立项审核与批准

Program review and approval



民航局空管局根据地区空管局管制业务相关情况和工作计划对提出的CDO/CCO应用项目进行审核，如有必要，则批准项目。

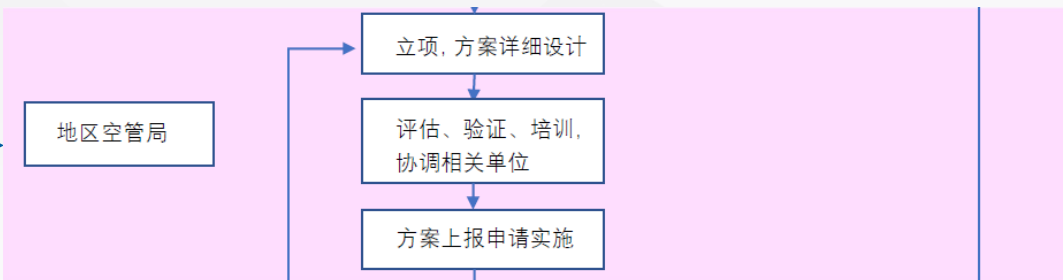
ATMB is responsible to review the CDO/CCO programme proposed by regional ATMB, and will put it in plan if applicable.



完善工作程序 Establish working process



4、项目实施 Program organization



协调相关单位
Coordinate stakeholders

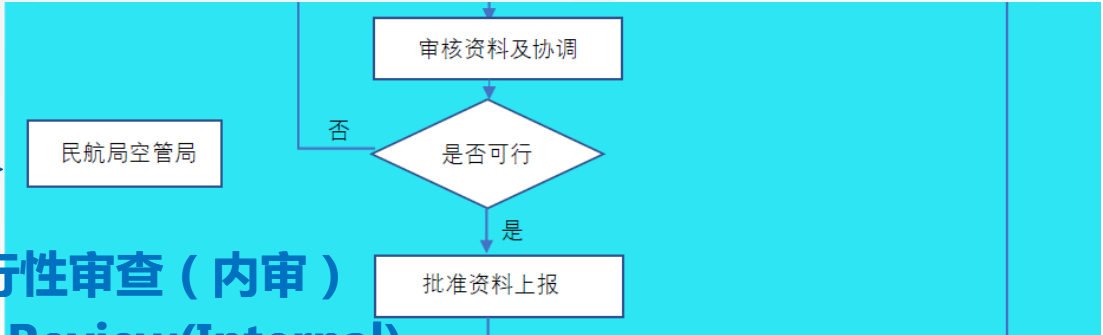
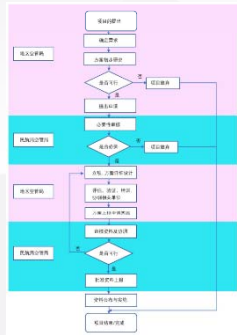
方案详细设计
Detailed design

内部评估和验证
Internal evaluation and validation

方案上报, 实施申请
Apply for procedure review & implementation



完善工作程序 Establish working process



5、设计方案及实施可行性审查（内审） Design & Feasibility Review (Internal)

民航局空管局对地区空管局的CDO/CCO设计方案和管制运行方案进行审核。ATMB will conduct the internal reviews in respect of technical issues.

- 可行，地区空管局协调相关方完成相关资料的报审工作
If applicable, Regional ATMB will arrange related documents for authority approval
- 需优化，地区空管局根据意见建议继续优化完善相关内容
If not, Regional ATMB will continue to optimize the plan



扩大应用阶段 The Expansion Phase

April 2020, Urumqi Intl.

Changchun Intl. estimated in 2021

Beijing Capital & Beijing Daxing Intl.
estimated in 2021

April 2020, Xi'an Intl.

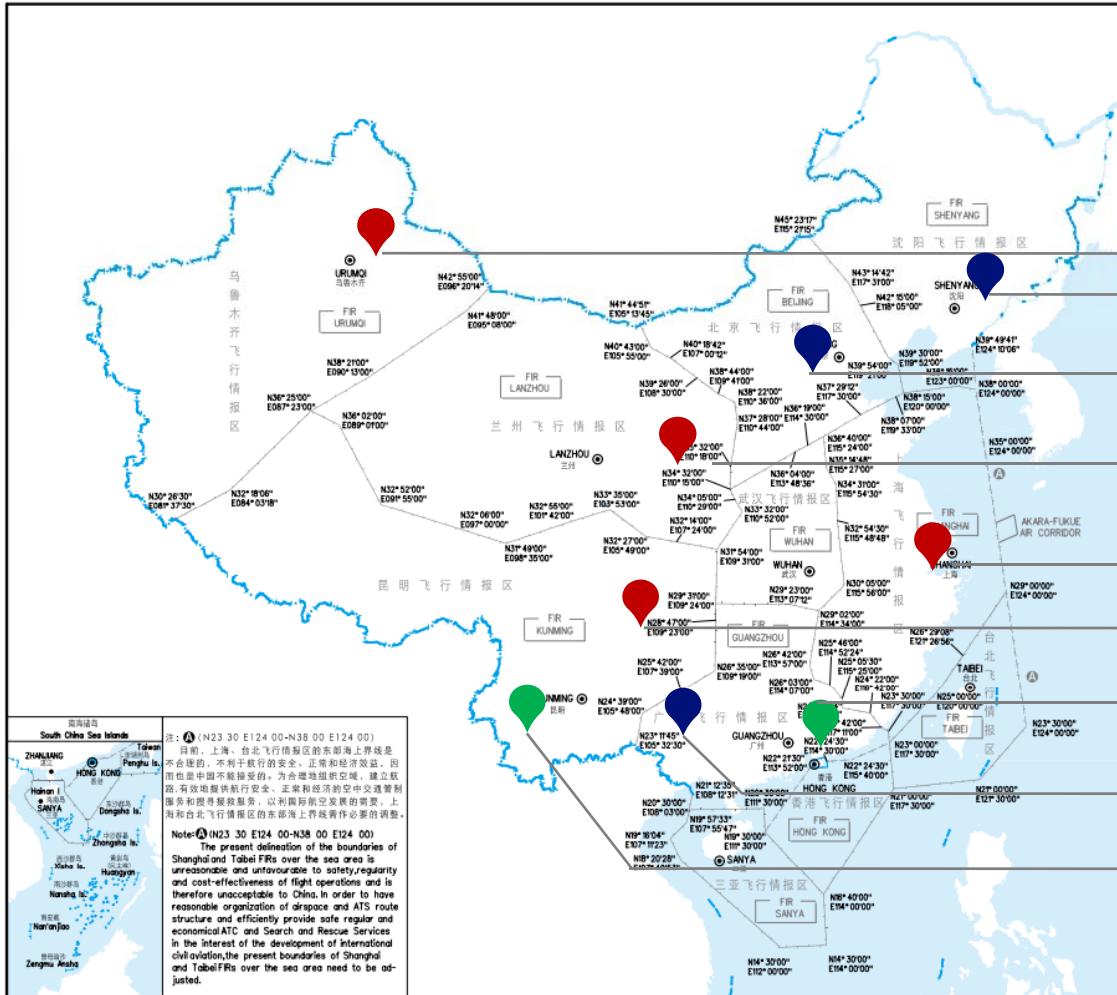
December 2019, Shanghai Pudong Intl.

February 2020, Chongqing Intl.

January 2019, Guangzhou Intl. on regular basis

Guilin Intl. estimated by end of 2020

July 2019, Kunming Intl. on regular basis



04

应用成效

Effects



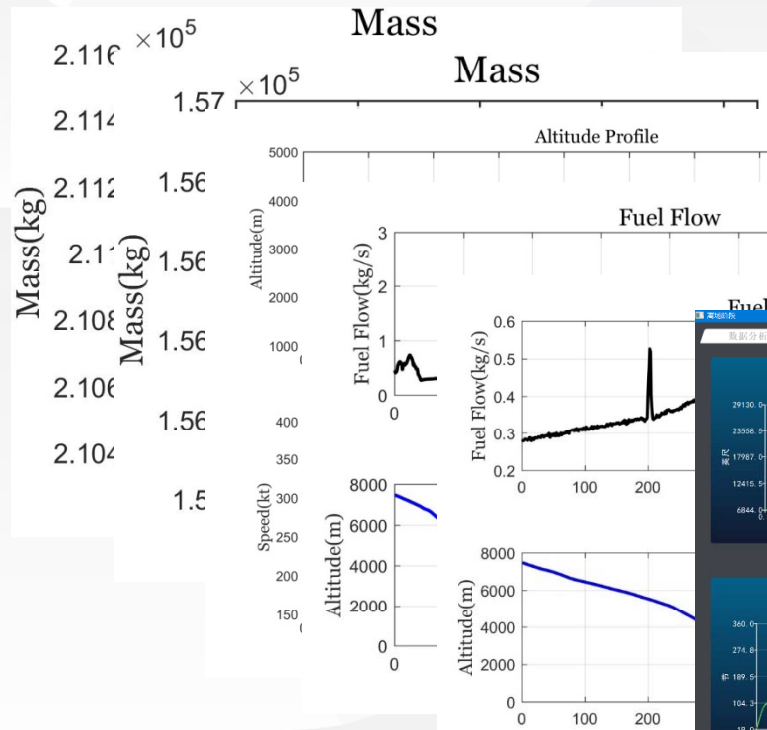
评估方法 Evaluation methods

节能评估方法 Fuel Saving Assessment Methods :

- 主要有：**直接**评估法与**间接**评估法。The Direct & Indirect Assessment
- 直接评估法 The Direct Assessment ——利用飞机QAR数据开展油耗评估。
Aircraft QAR data
- 间接评估法 The Indirect Assessment——利用相关模型算法拟合/估计航空器燃油消耗。Model simulation and estimation

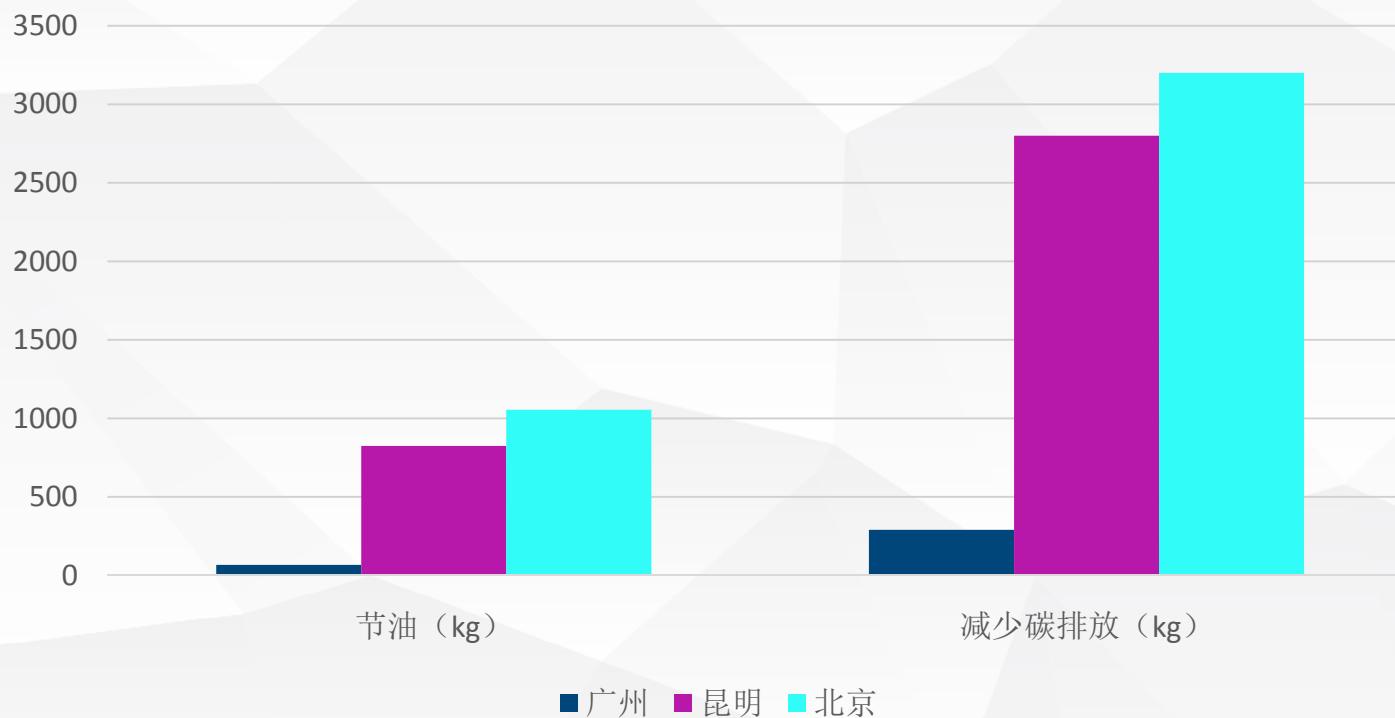


成效评估 Benefits Assessment



试点应用成效 Trial Results

单次CDO运行成效对比 Benefits of Single CDO



➤➤ 今年成效 Overall Benefits This Year

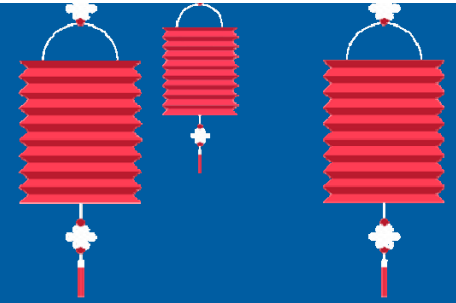
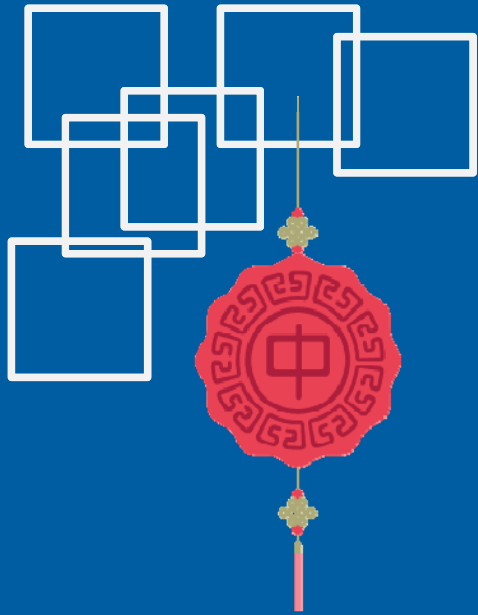
今年COVID-19在全球蔓延，严重影响航空运输业，上半年全球民航航班量骤减。
Due to the Covid-19 impact on the civil aviation industry, the air traffic decrease sharply all over the world.

2020年上半年在我国已有CDO/CCO运行地区，共计执行CDO/CCO 956架次。
In the first half of 2020, 956 flights operated on CDO/CCO in China.

共计减少燃油消耗约124.8吨。
Fuel consumption decrease 124.8 ton.

共比较少碳排放约347.8吨。
Carbon emission decrease 347.8 ton.





感谢您的聆听 Thank you

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Mr. Ma Linnan, malinnan@vip.163.com

