Implementation and Assessment of RECAT-CN in China

2023.6

Outline

- Introduction
- Implementation of RECAT-CN
- Assessment of RECAT-CN
- Summary

Introduction

- PANS-ATM, Doc 4444:
  wake turbulence is used to describe the effect of the rotating air masses generated behind the wing tips of aircraft, in preference to the term "wake vortex" which describes the nature of the air masses.
- Amendment 9 to the PANS-ATM (Doc 4444) approved on 19 May 2020, for applicability on 05 November 2020

  ✓ *address A380 wake separation minima – "SUPER (J)"*
  ✓ *introduction of wake turbulence groups, as an alternative means that States can choose to adopt*
  ✓ *reduction of separation minima for some traffic pairs of aircraft, enabling runway throughput increase*

Introduction

- Wake Turbulence Categories and Groups

4.9.1.1 Except as provided for in 4.9.1.2, wake turbulence separation minima shall be based on a grouping of aircraft types into four categories according to the maximum certificated take-off mass as follows:

a) SUPER (J) — aircraft types specified as such in Doc 8643, *Aircraft Type Designators*;

b) HEAVY (H) — aircraft types of 136 000 kg or more, with the exception of aircraft types listed in Doc 8643 in the SUPER (J) category;

c) MEDIUM (M) — aircraft types less than 136 000 kg but more than 7 000 kg; and

d) LIGHT (L) — aircraft types of 7 000 kg or less.

Note.— The wake turbulence category for each aircraft type is contained in Doc 8643, Aircraft Type Designators.

PANS-ATM (Doc 4444)

a) GROUP A — aircraft types of 136 000 kg or more, and a wing span less than or equal to 80 m but greater than 74.68 m;

b) GROUP B — aircraft types of 136 000 kg or more, and a wing span less than or equal to 74.68 m but greater than 53.34 m;

c) GROUP C — aircraft types of 136 000 kg or more, and a wing span less than or equal to 53.34 m but greater than 38.1 m;

d) GROUP D — aircraft types less than 136 000 kg but more than 18 600 kg, and a wing span greater than 32 m;

e) GROUP E — aircraft types less than 136 000 kg but more than 18 600 kg, and a wing span less than or equal to 32 m but greater than 27.43 m;

f) GROUP F — aircraft types less than 136 000 kg but more than 18 600 kg, and a wing span less than or equal to 27.43 m;

g) GROUP G — aircraft types of 18 600 kg or less (without wing span criterion).

Note 1.— Information on the wake turbulence group for each aircraft type is contained in Doc 8643, Aircraft Type Designators.

Note 2.— Guidance on the implementation of wake turbulence separation between wake turbulence groups can be found in the Manual on Implementation of Wake Turbulence Separation Minima *(Doc 10122).*

Implementation of RECAT-CN

FAA RECAT-I

Follower

Wake separation		J	H		M		L
		A	B	C	D	E	F
J	A		5nm	6nm	7nm	7nm	8nm
H	B		3nm	4nm	5nm	5nm	7nm
	C				3.5nm	3.5nm	6nm
M	D						4nm
	E						
L	F						

Leader

No difference when D and E as follower a/c

Little difference when D and E as leader a/c

Implementation of RECAT-CN

- **Flights at Guangzhou airport and Shenzhen airport**

CAT	Total Number	a/c type	Number	Percentage
J	148	A380	148	100.00%
H	2797	A330	1469	52.52%
		B777/B787	1229	43.94%
	482	B763	394	81.74%
		MD11	87	18.04%
M	16197	A320	7802	48.17%
		B738	7314	45.16%
		E190	647	3.99%
L	0	---	0	0
Total	19624	---	19003	96.84%

No Light aircraft at the Large hub airports

No need to subdivide Medium aircraft

Implementation of RECAT-CN

What are the a/c categories in RECAT-CN?

- The more categories, the more separation can be reduced, the more airport capacity can improve, but the more complex and workload for ATC.
- Heavy aircraft is divided into Categories B and C (ref. FAA ORDER 7110.659C). The other categories of aircraft remain the same.
- B752、B753 are classified as Medium a/c.

Category	Maximum Takeoff weight(kg)	Span(m)
J	≥136000	≥75
B	≥136000	54-75
C	≥136000	<54
M	7000~136000	
L	≤7000	

Implementation of RECAT-CN

What is the separation in RECAT-CN?

- For aircraft pairs wake turbulence separation criteria shall be in accordance with the following provisions.
- For B and C a/c, the separation in FAA ORDER 7110.659Cis used, the others are the same as the ICAO separation.
-

Follower / Leader	J A380-800	Heavy B	Heavy C	Medium M	Light L
J A380-800	MRS	9.3km	11.1km	13km	14.8km
Heavy B MTOW≥136t	MRS	5.6km	7.4km	9.3km	13km
Heavy C MTOW≥136t	MRS	MRS	MRS	6.5km	11.1km
Medium M 7t≤MTOW＜136t	MRS	MRS	MRS	MRS	9.3km
Light L MTOW＜7t	MRS	MRS	MRS	MRS	MRS

Implementation of RECAT-CN

RECAT-CN Timeline in China

In 2015, CAAC issued the ASBU Development and Implementation Strategy for China Civil Aviation which included wake turbulence separation.

2015

2015

In 2015, the Air Traffic Management Bureau (ATMB) of CAAC and the Civil Aviation University of China (CAUC) cooperated in the project of Feasibility Study and Validation of Technology for Reducing Wake Turbulence Separation Based on RECAT.

2019

On December 5, 2019, China started the RECAT-CN test operation in Guangzhou Baiyun Airport and Shenzhen Baoan Airport.

Implementation of RECAT-CN

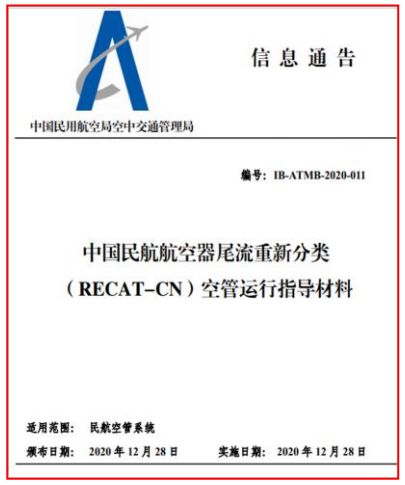
RECAT-CN Timeline in China

In December 2020, the RECAT-CN test operation was implemented at 12 major airports in China, including Beijing Capital Airport and Shanghai Hongqiao Airport.

2020

2020

2023



信 息 通 告

中国民用航空局空中交通管理局

编号：IB-ATMB-2020-011

中国民航航空器尾流重新分类
（RECAT-CN）空管运行指导材料

适用范围： 民航空管系统

颁布日期： 2020 年 12 月 28 日　　实施日期： 2020 年 12 月 28 日

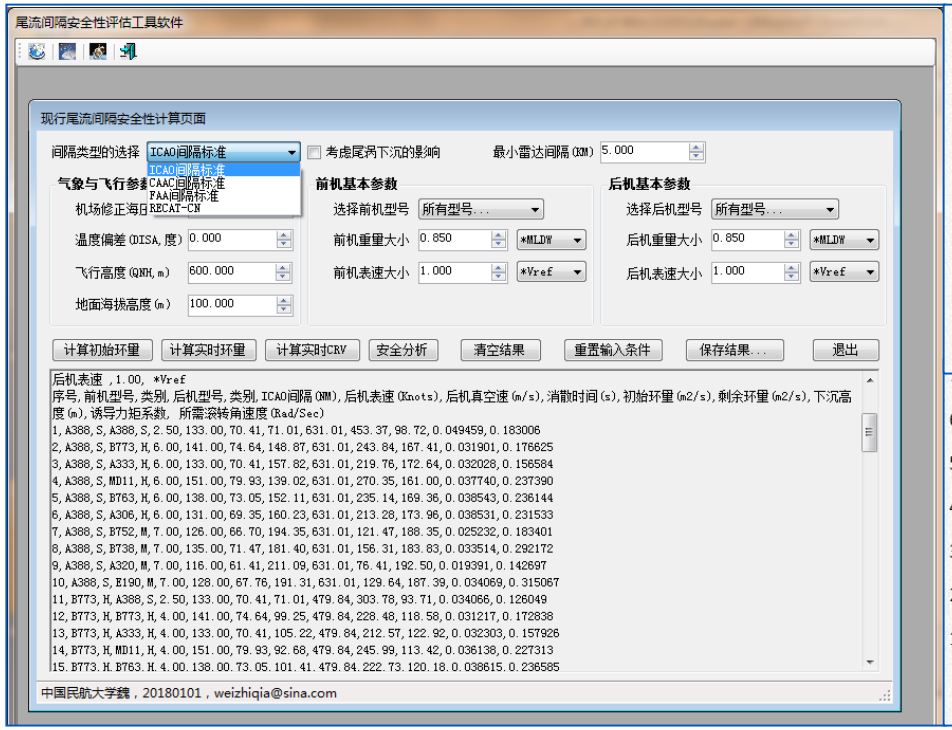
In the end of 2020, CAAC issued *the guidance materials of RECAT-CN for air traffic control operations* to ATC units to guide the implementation of experimental operations and statistical analysis of the effectiveness of RECAT.

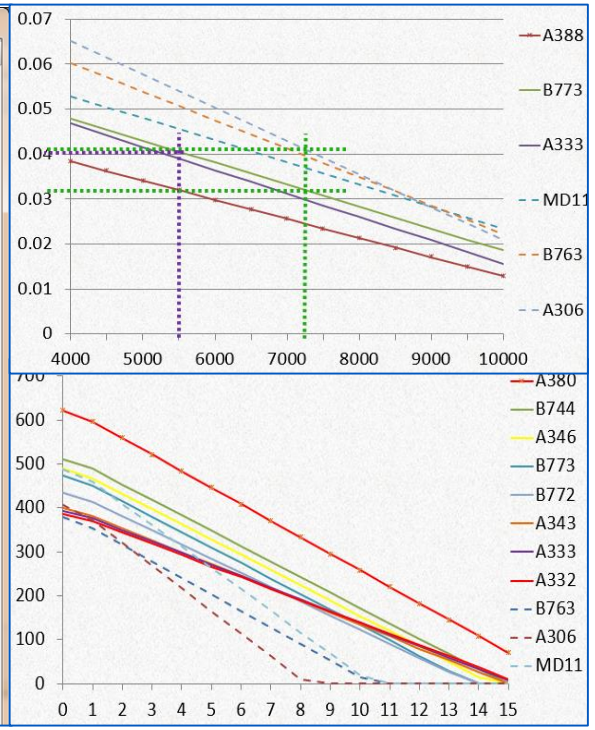
In 2023, further operations of RECAT-CN will be carried out at more airports.

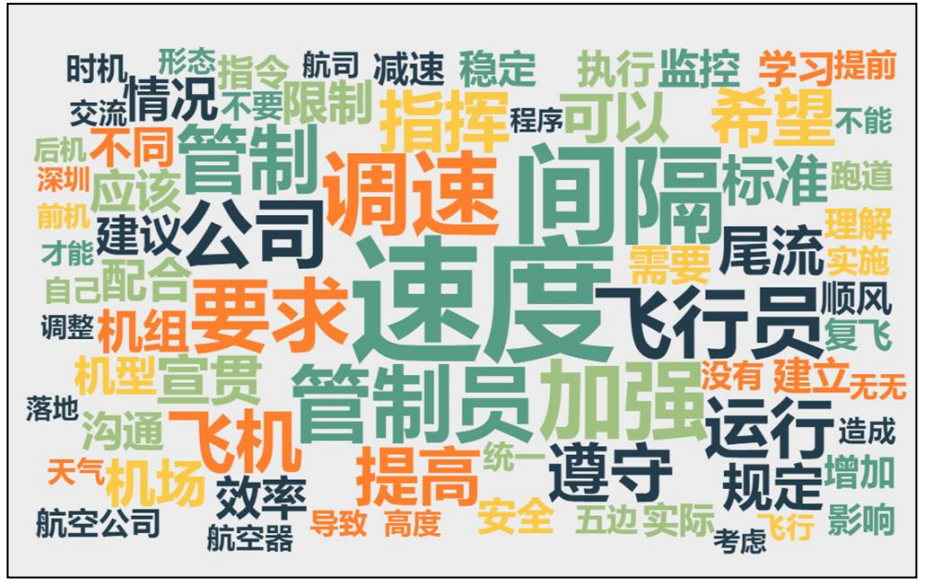
Implementation of RECAT-CN

Pre-Trial Analysis

- Based on CFD calculation data and liDAR detection data, establish a safety evaluation model and develop a tool software to evaluate the safety of RECAT-CN
- Investigate and analyze of pilot's opinions on the trial operation of RECAT-CN







Implementation of RECAT-CN

RECAT-CN Implementation Results

- The actual operation data show that the wake turbulence separation can be reduced by a maximum of 23%, and the average capacity increase is about 2%.
- The additional cost required to implement the RECAT-CN is little, including the cost in the upgrading of wake turbulence identification and personnel training in the ATC automation system. Airlines do not need to change the aircraft categories in the ICAO flight plan.

Assessment of RECAT-CN

Indicators to assess RECAT-CN

1. **Number of flights that meet the requirements of category combination (N):** within the statistical time period, the number of flights that meet the requirements of the pair category combinations (i.e. JB, BB, CB, CC, CM), or the leading aircraft is B757 aircraft.
2. **The number of flights that have implemented the RECAT-CN (N_{RECAT}):** within the statistical time period, the following requirements are met:
   - ✓ (a) the pair category combinations (i.e. JB, BB, CB, CC, CM) or the leading aircraft is a B757 aircraft ;
   - ✓ (b) The following aircraft is the experimental subject;
   - ✓ (c) The actual separation between the leading aircraft that is landing and the following aircraft is less than 1.5 times as much as the required separation(the RECAT-CN);

Assessment of RECAT-CN

Indicators to assess RECAT-CN

3. **Percentage of the number of the flights that have implemented the RECAT-CN (P_{RECAT}):** The percentage of the number of flights that have implemented the RECAT-CN in the number of flights that meet the category combinations.

$$P_{\mathrm{RECAT}} = \frac{N_{\mathrm{RECAT}}}{N}$$

4. **The number of flights that implement the RECAT-CN precisely ($N_{precision}$):** when the leading aircraft enters the runway and lands, the actual separation with the following aircraft is less than 1.3 times as much as the required separation (RECAT-CN).

Assessment of RECAT-CN

Indicators to assess RECAT-CN

5. **Accurate implementation rate of the RECAT-CN ($P_{precision}$)**: The ratio of the number of flights that accurately implement the RECAT-CN to the number of flights that have implemented the RECAT-CN, which is:

$$P_{\text{precision}} = \frac{N_{\text{precision}}}{N_{\text{RECAT}}}$$

6. **The reduced separation rate of the RECAT-CN ($P_{ReducedSeparation}$)**:

$$P_{\text{ReducedSeparation}} = \frac{\sum_{i=1}^{N_{\text{RECAT}}} \left(\frac{S_{i_{\text{CAAC}}} - S_{i_{\text{RECAT}}}}{S_{i_{\text{CAAC}}}} \right)}{N_{\text{RECAT}}}$$

Assessment of RECAT-CN

Indicators to assess RECAT-CN

7. The number of flights that RECAT-CN can increase: the reduced separation rate multiplied by the number of flights that have implemented the RECAT-CN, which is:

$$\Delta N = P_{\text{ReducedSeparation}} \times N_{\text{RECAT}}$$
$$= P_{\text{ReducedSeparation}} \times P_{\text{RECAT}} \times N$$

8. Relative RECAT-CN separation ($S_{\text{relativeRECAT}}$):

$$S_{\text{relativeRECAT}} = \frac{\sum_{i=1}^{N_{\text{RECAT}}} \left(\frac{S_{i_{\text{really}}}}{S_{i_{\text{RECAT}}}} \right)}{N_{\text{RECAT}}}$$

Assessment of RECAT-CN

Indicators to assess RECAT-CN

9. Relative current separation ($S_{relativeCAAC}$):

$$S_{\text{relativeCAAC}} = \frac{\sum_{i=1}^{N_{\text{RECAT}}} \left(\frac{S_{i_{\text{really}}}}{S_{i\ CAAC}} \right)}{N_{\text{RECAT}}}$$

10. Relative required separation ($S_{relativeRequirement}$): the ratio of the actual separation between the leading aircraft that is landing and the following aircraft to the required separation criteria.

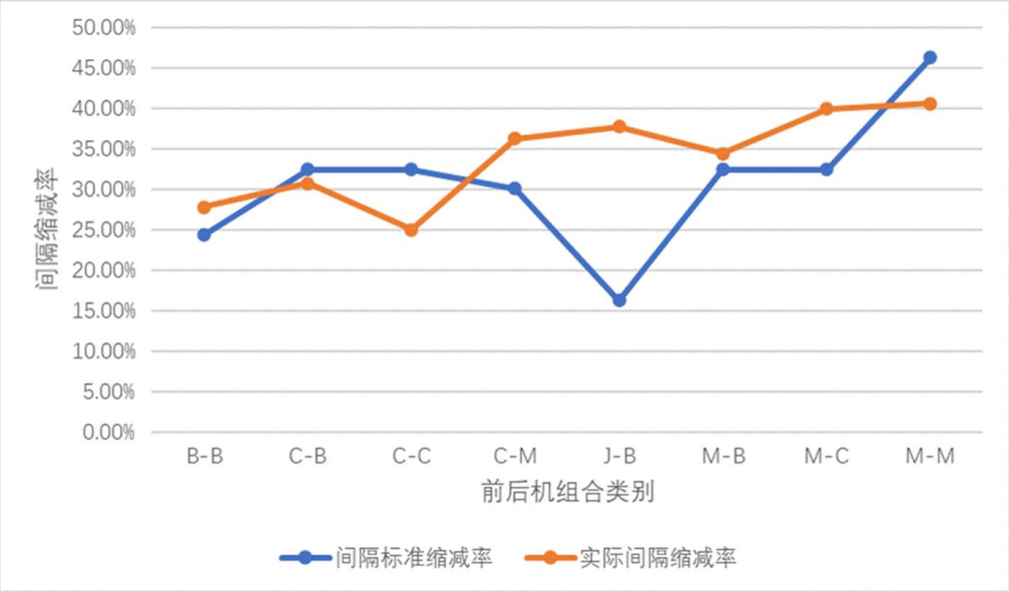
Assessment of RECAT-CN

Assessment of RECAT-CN implementation

Statistical indicators	1st month		2nd month		3rd month	
	Implement	Not implement	Implement	Not implement	Implement	Not implement
Number of flights that meet requirements of the category combination	491	361	388	301	429	313
Number of flights that have implemented the RECAT	229	/	197	/	131	/
Percentage of flights that have implemented the RECAT	46.64%	/	50.77%	/	30.54%	/
Number of flights that accurately implement the RECAT	120	/	110	/	59	/
Percentage of flights that accurately implement the RECAT	52.40%	/	55.84%	/	45.04%	/
Reduced separation rate for the RECAT (average)	21.14%	/	20.90%	/	20.93%	/
Number of flights that the RECAT can increase	48.40	35.58	41.17	31.94	27.42	20.00
Relative RECAT separation (average)	1.2793	/	1.2705	/	1.2958	/
Relative current separation (average)	1.0082	1.2549	1.0038	1.2359	1.0229	1.3069
Relative required separation (average)	1.2793	1.2549	1.2705	1.2359	1.2958	1.3069

Summary

- After the implementation of the RECAT, the separation on the final is reduced by about 20% for the flight pairs that meet the requirements of the pair category combinations.
- On the controller's side, there is no significant difference between the implementation of the RECAT separation and that of the original separation criteria, so the controller is proficient in implementing the RECAT separation criteria.



a/c pair	Reduction rate of Separation Minimum	Actual reduction rate of Separation
B-B	24.32%	27.82%
C-B	32.43%	30.73%
C-C	32.43%	24.97%
C-M	30.11%	36.25%
J-B	16.22%	37.72%
M-B	32.43%	34.41%
M-C	32.43%	39.93%
M-M	46.24%	40.60%

Thank you