

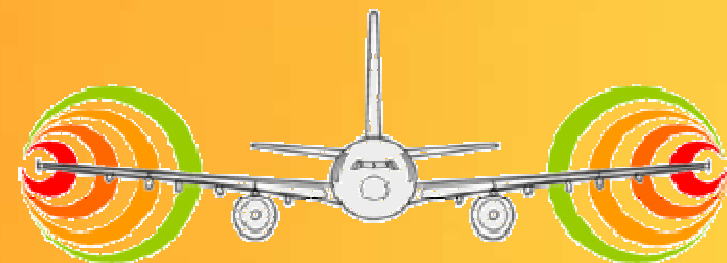


**European Proposed RECAT Amendment for Capacity Optimisation  
WakeNet3-Europe**

**4th Major & Final Workshop  
Wake Turbulence in Current Operations and Beyond**

**Prepared by :**

Vincent Treve (EUROCONTROL)



***WakeNet3-Europe***

*A network on Aircraft Wake Turbulence*



# Introduction

A first RECAT proposal (RECAT A) was presented at ICAO end of last year

During consultation/review process, stakeholders identified some improvements to the initial proposal that could lead to significant capacity improvement

This presentation introduces the key principles on which EUROCONTROL, will propose an amendment the current RECAT proposal (RECAT B) for capacity optimization

The following results and separation tables should only be considered as EUROCONTROL initial proposal to be consolidated through a new consultation process involving all stakeholders



# Outline

1. RECAT key principles
2. RECAT proposal
3. RECAT potential improvement
4. RECAT amendment key principles
5. RECAT amendment safety assessment
6. RECAT amendment proposal
7. RECAT amendment capacity assessment
8. Next steps



# RECAT key principles

1. A list of 61 aircraft representing 85% of the U.S. and European traffic (operations) is used for the analysis

AC TYPE
A380
B744
A346
B773
B772
A343
A333
A332
MD11
B763
A306
B753
B752
B739
B738
B737
B736
A319
A318
A321
A320
B722
MD83
MD82
F50
B734
B733
B735
E190
B717
GLF5
DC95
DC93
DH8D
F100
F70

AC TYPE
DH8C
A172
RJ100
RJ85
B463
B462
E170
DH8B
DH8A
CRJ9
AT45
AT43
GLF4
CRJ7
SB34
CRJ2
CRJ1
E45X
E145
E135
E120
B190
C650
H25B
C525



# RECAT key principles

2. Using the vortex circulation decay line in eqn. 9, the approach speed profile shown in Figure 3, and the aircraft characteristics database in Table 1, the vortex circulations generated by the lead aircraft at the ICAO separation minima for the 61x61 leader-follower aircraft pairs are computed

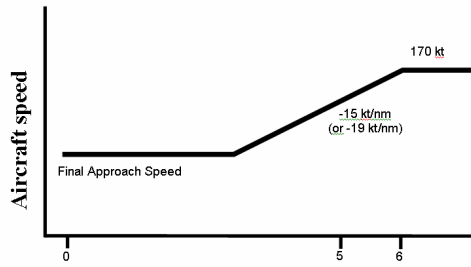
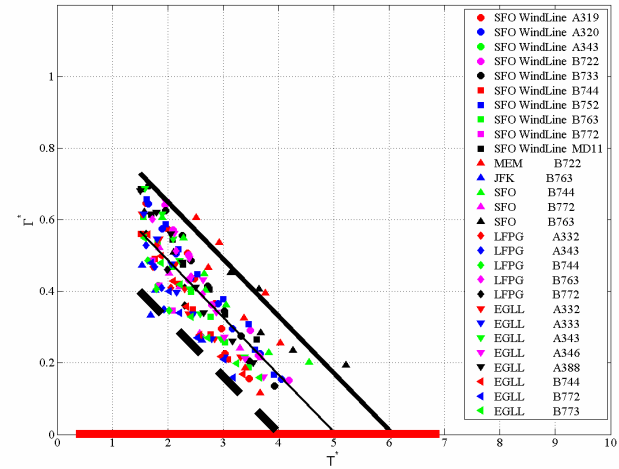


Figure 3

ACT TYPE	Aircraft name	MTRW0	MUNW0	GRAND	WINGSPN (sq ft)	Aspect ratio	Tare wt (lb)	CL max (deg)	CL max (rad)	Approach speed @ 5 DME (kt)	% of tail span for greatest effect
A320	A320	124800	80680	261.7	8669.5	7.520154	0.224898	4.013815	-0.4715	133	35
A340	A340-600	80000	52000	231	5635	7.766695	0.27792	4.668951	-0.5056	146	35
A340	A340-300	36825	26480	208.1	4703.9	8.26818	0.3	5.118123	-0.4877	141	35
A341	A340-300	36685	26430	199.4	3992.2	10.82201	0.318814	5.982964	-0.4774	132	35
B772	B777-300	86000	52480	190.9	4605	8.977268	0.148374	5.058803	-0.4426	141	35
B773	B777-300	86000	44500	189.4	4605	8.977268	0.148374	5.058803	-0.4426	139	35
A330	A330-300	60710	40725	197.9	3802.2	8.991225	0.218813	5.119192	-0.4775	133	35
B747	B747-400	80710	58600	197.9	3802.2	10.82201	0.318814	5.982964	-0.4774	132	35
B748	B747-400	40000	32000	196.1	3698	7.853642	0.272713	4.573342	-0.5057	135	35
B749	B747-400	40000	32000	196.1	3698	7.853642	0.272713	4.573342	-0.5057	135	35
A321	A321	82000	49100	186.1	3646	7.970181	0.249911	5.180482	-0.4774	131	35
B737	B737-300	27000	22400	124.8	1904	7.810915	0.217397	4.951872	-0.4775	131	35
B738	B737-300	27000	19800	124.8	1904	7.810915	0.217397	4.951872	-0.4775	128	35
A321	A321	20810	17117	111.3	1317.5	8.424212	0.249162	5.138192	-0.4775	135	35
B739	B737-300	17400	14600	112.8	1345.5	8.424212	0.249162	5.138192	-0.4775	135	35
B732	B737-300	16480	14480	109	1306	8.891796	0.251186	4.93761	-0.5212	129	35
A320	A320	16975	14222	111.3	1317.5	8.424212	0.249162	5.138192	-0.4775	135	35
B737	B737-700	16447	13776	111.8	1317.5	8.846263	0.249162	5.138192	-0.4775	135	35
B737	B737-700	16400	12920	112.8	1345.5	8.424212	0.249162	5.138192	-0.4775	135	35
A319	A319	14952	12676	111.8	1317.5	8.846263	0.249162	5.138192	-0.4775	135	35
B738	B737-700	14500	12000	112.8	1345.5	8.424212	0.249162	5.138192	-0.4775	135	35
B734	B737-700	14500	12000	109	1306	8.846263	0.249162	5.138192	-0.4775	135	35
B734	B737-700	13800	12100	94.8	1138	7.910993	0.26	4.968097	-0.4867	130	35
B735	B737-700	14500	12000	109	1306	8.846263	0.249162	5.138192	-0.4775	135	35
B735	B737-700	13800	11400	94.8	1138	7.910993	0.26	4.968097	-0.4867	128	35
B735	B737-700	13400	11000	94.8	1135	7.914081	0.26	4.963987	-0.4867	122	35
B737	B737-700	12300	11000	94.8	1100.7	8.7147	0.269828	5.055466	-0.4729	132	35
B738	Amb-A319	8750	8950	95.5	932	8.930081	0.4	5.093287	-0.5575	119	35
B461	Bombardier CRJ-900	9950	9950	95.5	932	8.930081	0.4	5.093287	-0.5575	117	35
B463	Bombardier CRJ-900	9950	9950	95.4	932	8.972397	0.415429	5.094972	-0.5566	116	35
B462	Bombardier CRJ-900	9950	9950	95.2	932	8.972397	0.415429	5.094972	-0.5566	116	35
B464	Bombardier CRJ-900	9950	9950	95.4	932	8.972397	0.415429	5.094972	-0.5566	116	35
B465	Bombardier CRJ-900	9950	9950	95.2	932	8.972397	0.415429	5.094972	-0.5566	116	35
DC91	DC-9-30	12200	11000	91.3	1000.7	8.698091	0.26	5.007048	-0.4921	128	35
DC92	DC-9-30	11000	9900	91.3	1000.7	8.698091	0.26	5.007048	-0.4921	122	35
EMB3	Embraer E175	12200	11000	91.3	1000.7	8.698091	0.26	5.007048	-0.4921	128	35
E175	EMB-175	7314	7211	85.4	677.6	11.48487	0.29	5.208728	-0.5195	125	35
E175	EMB-175	8000	7800	81.1	1004.4	8.424212	0.249162	5.138192	-0.4775	124	35
E175	EMB-175	8000	7500	91.5	1107	7.988742	0.33	4.932564	-0.5089	130	35
E175	EMB-175	8100	7400	91.1	1004.4	8.424212	0.249162	5.138192	-0.4775	124	35
E75	Embraer E75	4581	4300	80	791.5	12.17723	0.46	5.162288	-0.4811	107	35
E75	Embraer E75	4581	4300	80	791.5	12.17723	0.46	5.162288	-0.4811	107	35
A771	A77-3	4591	4768	89.9	691.6	12.56653	0.51897	5.348878	-0.5659	103	35
A772	A77-3	4591	4768	89.9	691.6	12.56653	0.51897	5.348878	-0.5659	103	35
CRJ2	CRJ-900	8450	8450	91.3	1000.7	8.698091	0.26	5.007048	-0.4921	124	35

Table 1



decay line in eqn. 9



# RECAT key principles

## 3. Principle 1

To allow for capacity increases, the vortex strength of potential encounters for a follower aircraft is allowed to be increased to the maximum median vortex strength potentially encountered by this aircraft following any of the 61 aircraft under current ICAO separations

Exemple:

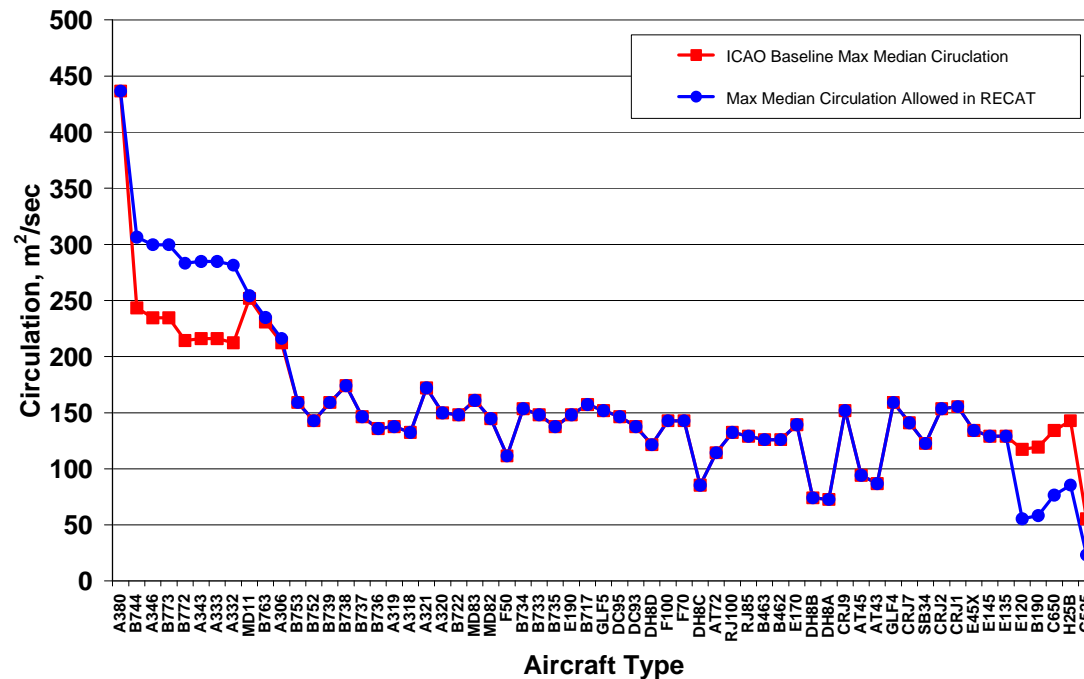
1. Medium X behind B744 @ 5 Nm encounter a wake of maximum  $300\text{m}^2/\text{s}$
2. Medium X behind B763 @ 5 Nm encounter a wake of maximum  $250\text{m}^2/\text{s}$
3. Medium X separation behind B763 can be reduced @3.5Nm if the wake encountered doesn't exceed  $300\text{m}^2/\text{s}$



# RECAT key principles

## 4. Principle 2

The maximum allowable circulations for aircraft in the current ICAO Heavy category are allowed to increase to the blue circles shown for the A332 to the B744 in Figure 4. These increases are based on using the rolling moment coefficient as the severity metric for these aircraft (combined with the roll control authority)



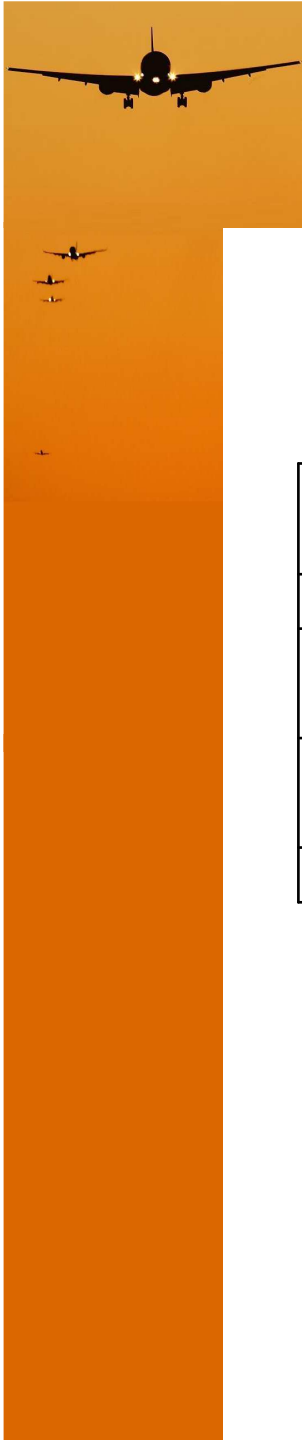


# RECAT proposal

ICAO

	S	H	M	L
S				
H		4	5	6
M		2.5	2.5	5
L		2.5	2.5	2.5

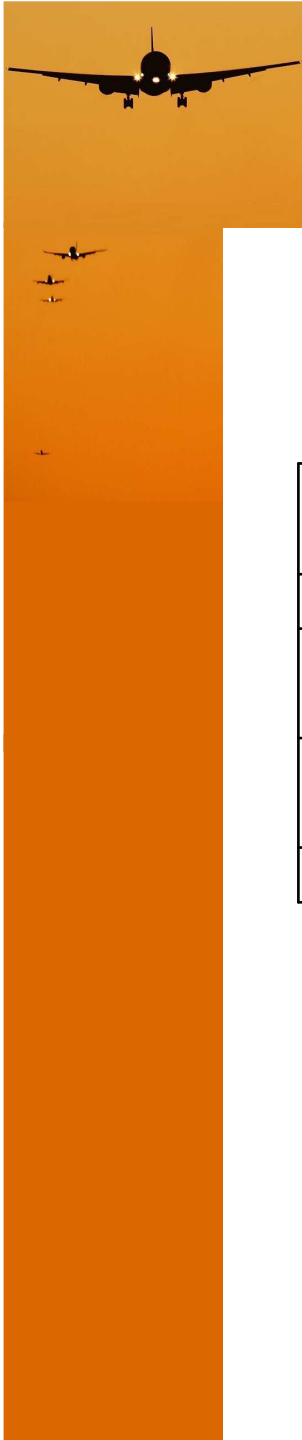




# RECAT proposal

ICAO

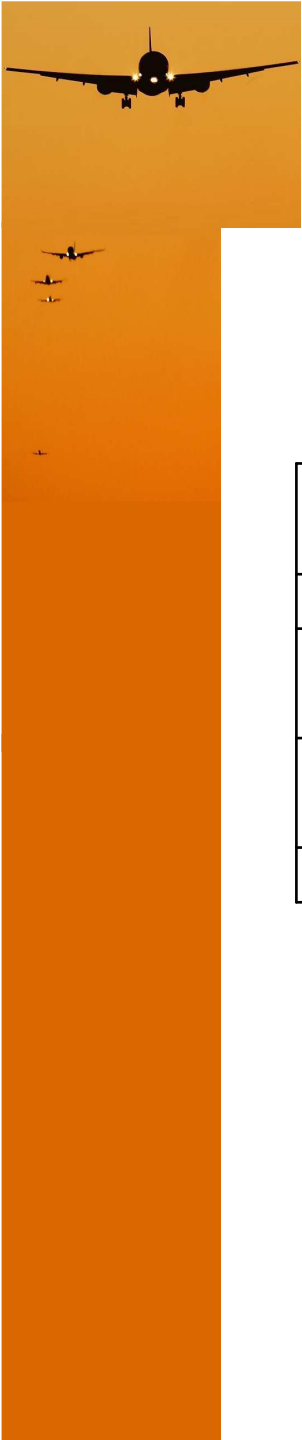
		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		4.0	4.0	5.0	5.0	6.0
	C		4.0	4.0	5.0	5.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT proposal

## RECAT A

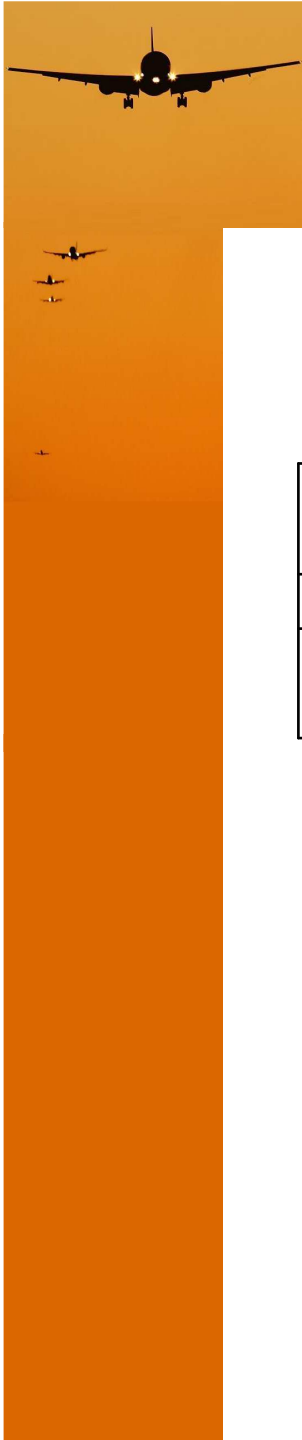
		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	5.0	5.0	6.0
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT proposal

## RECAT A

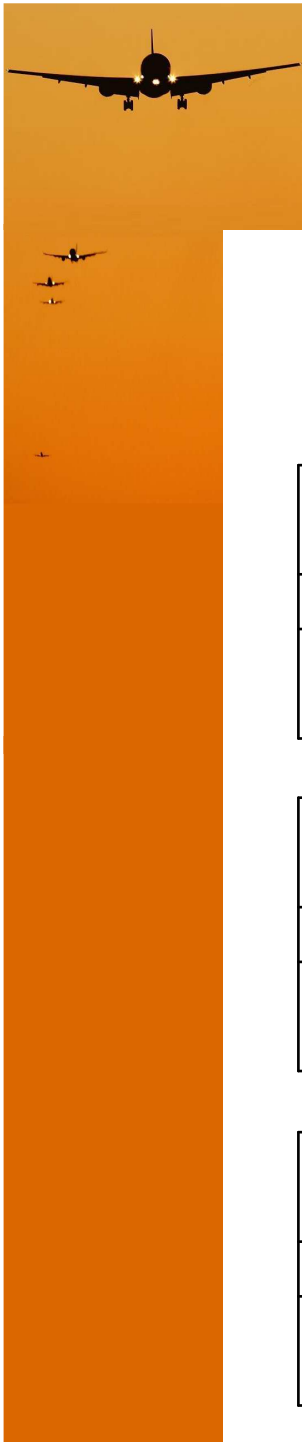
		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		<b>3.0</b>	4.0	5.0	5.0	6.0
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT proposal

## RECAT A

		S	H		M	
		A	B	C	D	E
S	A					
H	B		<b>3.0</b>	4.0	5.0	5.0
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>



# RECAT potential improvement

Percentage of pairs potentially reduced:

RECAT A    RECAT B

EGLL		S	H		M	
		A	B	C	D	E
S	A					
H	B		13%	2%	10%	~0%
	C		3%		3%	

19%

29%

LFPG		S	H		M	
		A	B	C	D	E
S	A					
H	B		5%	0.5%	9%	1.5%
	C		1.5%		2%	

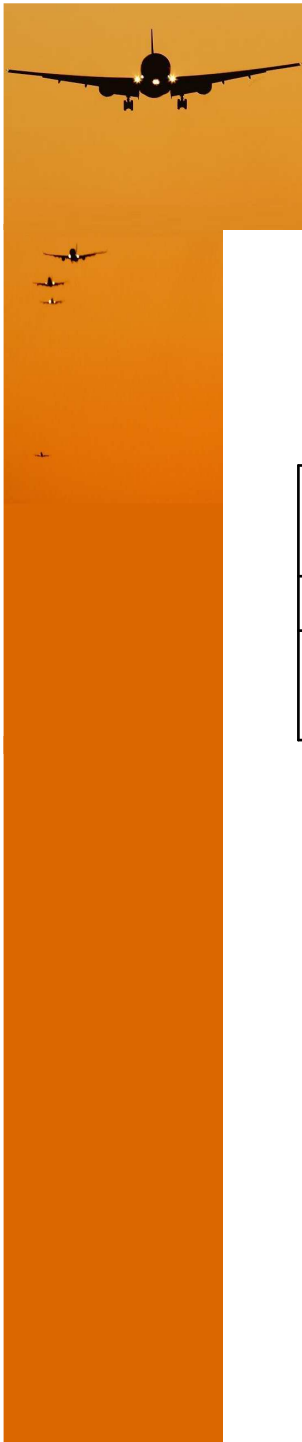
8.5%

17.5%

EDDF		S	H		M	
		A	B	C	D	E
S	A					
H	B		5.5%	1.5%	10%	1.5%
	C		1%		3.5%	

10%

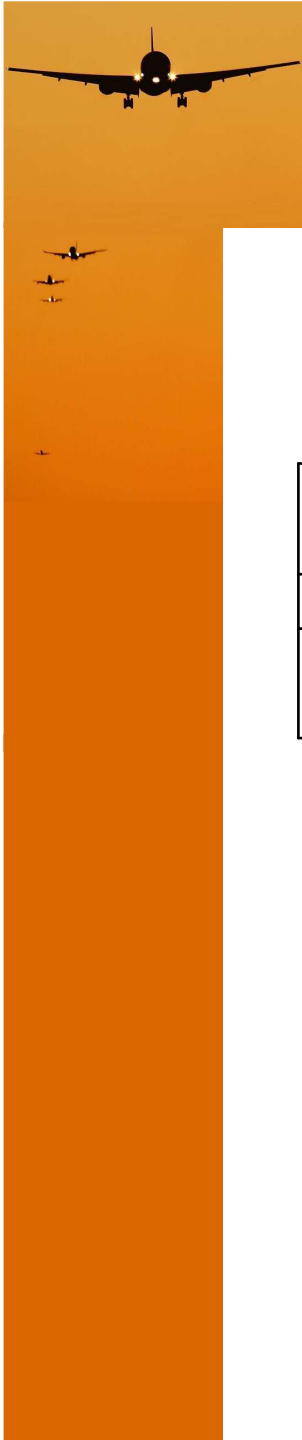
20%



# RECAT potential improvement

## RECAT A

		S	H		M	
		A	B	C	D	E
S	A					
H	B		<b>3.0</b>	4.0	5.0	5.0
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>



# RECAT potential improvement

## RECAT B

		S	H		M	
		A	B	C	D	E
S	A					
H	B		3.0	4.0	4.0	5.0
	C		2.5	2.5	3.5	3.5



# RECAT amendment key principles

1. CAT D is restricted to the very upper part of the Medium category

AC TYPE	ICAO	RECAT A
A380	S	1
B744	H	2
A346	H	2
B773	H	2
B772	H	2
A343	H	2
A333	H	2
A332	H	2
MD11	H	3
B763	H	3
A306	H	3
B753	H M	4
B752	H M	4
B739	M	4
B738	M	4
B737	M	4
B736	M	4
A319	M	4
A318	M	4
A321	M	4
A320	M	4
B722	M	4
MD83	M	4
MD82	M	4
F50	M	4
B734	M	4
B733	M	4
B735	M	4
E190	M	4
B717	M	4
GLF5	M	4
DC95	M	4
DC93	M	4
DH8D	M	4
F100	M	4
F70	M	4

AC TYPE	ICAO	RECAT A
DH8C	M	5
AT72	M	5
RJ100	M	5
RJ85	M	5
B463	M	5
B462	M	5
E170	M	5
DH8B	M	5
DH8A	M	5
CRJ9	M	5
AT45	M	5
AT43	M	5
GLF4	M	5
CRJ7	M	5
SB34	M	5
CRJ2	M	5
CRJ1	M	5
E45X	M	5
E145	M	5
E135	M	5
E120	L	6
B190	L	6
C650	L	6
H25B	L	6
C525	L	6





# RECAT amendment key principles

1. CAT D is restricted to the very upper part of the Medium category

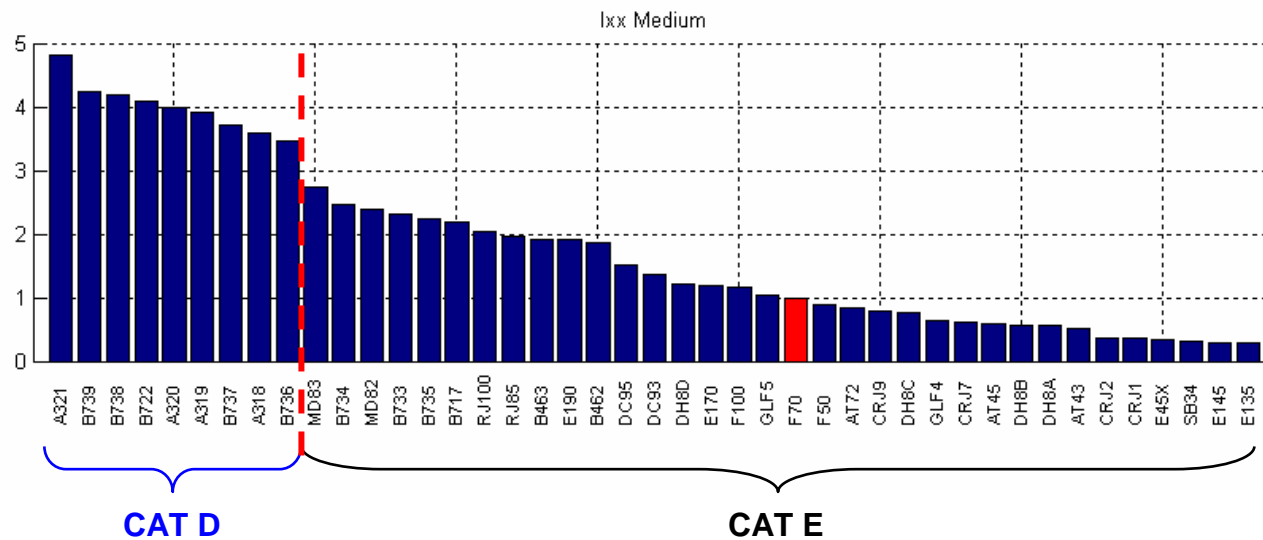
AC TYPE	ICAO	RECAT A	RECAT B
A380	S	1	1
B744	H	2	2
A346	H	2	2
B773	H	2	2
B772	H	2	2
A343	H	2	2
A333	H	2	2
A332	H	2	2
MD11	H	3	3
B763	H	3	3
A306	H	3	3
B753	H M	4	4
B752	H M	4	4
B739	M	4	4
B738	M	4	4
B737	M	4	4
B736	M	4	4
A319	M	4	4
A318	M	4	4
A321	M	4	4
A320	M	4	4
B722	M	4	4
MD83	M	4	5
MD82	M	4	5
F50	M	4	5
B734	M	4	5
B733	M	4	5
B735	M	4	5
E190	M	4	5
B717	M	4	5
GLF5	M	4	5
DC95	M	4	5
DC93	M	4	5
DH8D	M	4	5
F100	M	4	5
F70	M	4	5

AC TYPE	ICAO	RECAT A	RECAT B
DH8C	M	5	5
AT72	M	5	5
RJ100	M	5	5
RJ85	M	5	5
B463	M	5	5
B462	M	5	5
E170	M	5	5
DH8B	M	5	5
DH8A	M	5	5
CRJ9	M	5	5
AT45	M	5	5
AT43	M	5	5
GLF4	M	5	5
CRJ7	M	5	5
SB34	M	5	5
CRJ2	M	5	5
CRJ1	M	5	5
E45X	M	5	5
E145	M	5	5
E135	M	5	5
E120	L	6	6
B190	L	6	6
C650	L	6	6
H25B	L	6	6
C525	L	6	6



# RECAT amendment key principles

2. CAT B – CAT D pair is reduced because of the higher resistance of the upper Medium aircraft (in new CAT D)





# RECAT B safety assessment principles

1. The same list of 61 aircraft representing 85% of the U.S. and European traffic (operations) is used for the analysis

AC TYPE
A380
B744
A346
B773
B772
A343
A333
A332
MD11
B763
A306
B753
B752
B739
B738
B737
B736
A319
A318
A321
A320
B722
MD83
MD82
F50
B734
B733
B735
E190
B717
GLF5
DC95
DC93
DH8D
F100
F70

AC TYPE
DH8C
AT72
RJ100
RJ85
B463
B462
E170
DH8B
DH8A
CRJ9
AT45
AT43
GLF4
CRJ7
SB34
CRJ2
CRJ1
E45X
E145
E135
E120
B190
C650
H25B
C525

# RECAT B safety assessment principles

- Using vortex decay based on LIDAR measurement from EGLL and the approach speed profile shown in Figure 3, the vortex circulations generated by the lead aircraft at the ICAO separation minima for the 61x61 leader-follower aircraft pairs are computed

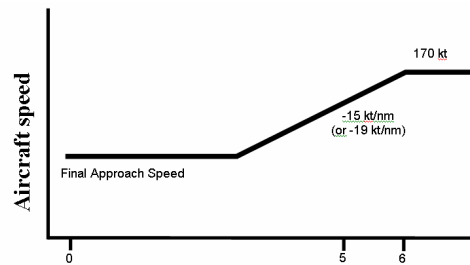
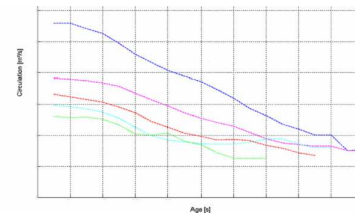
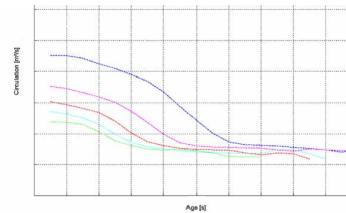


Figure 3



LIDAR measurement from EGLL



# RECAT amendment key principles

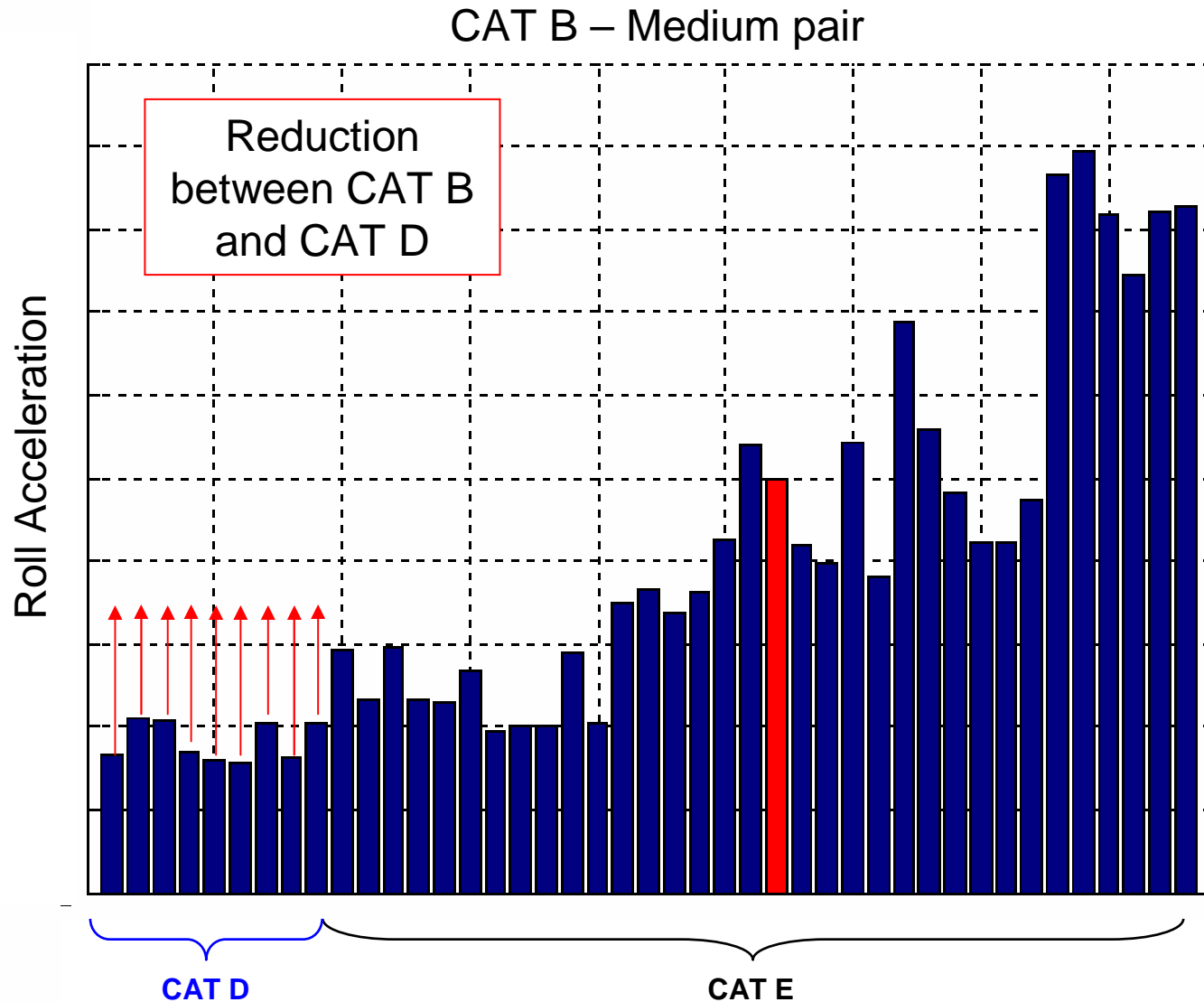
3. The severity of a potential encounter is assessed using :

$$\textit{Roll acceleration} = \frac{\Delta M_i}{I_j} \propto \frac{\Gamma_i \cdot V_{f_i} \cdot b_{f_i}^2}{I_j}$$

$$\textit{Rolling Moment Coefficient} \propto \frac{\Gamma_i}{V_{f_j} \cdot b_{f_j}}$$

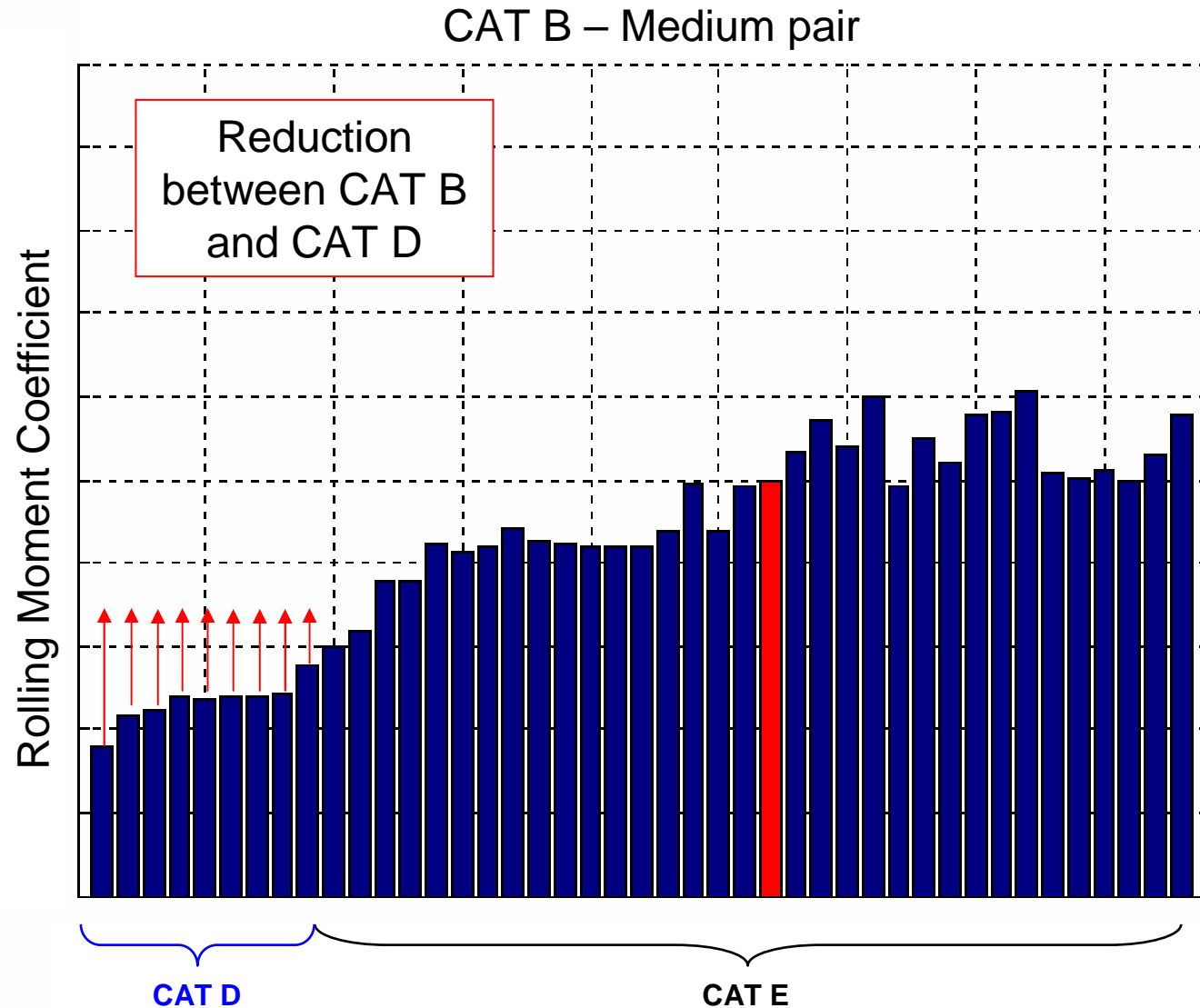


# RECAT amendment key principles





# RECAT amendment key principles





# RECAT amendment safety assessment

Heavy - Heavy





# RECAT amendment safety assessment

ICAO - Heavy-Heavy pairs

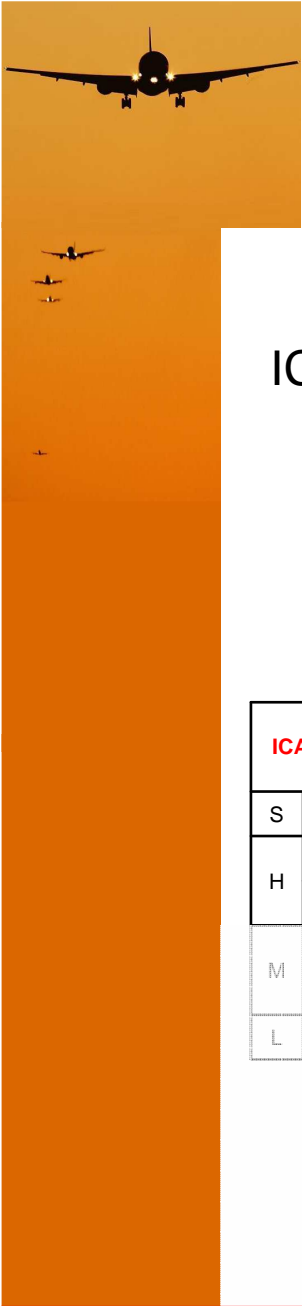
		S	H	
		A	B	C
S	A			
H	B	4.0	4.0	4.0
	C		4.0	4.0



# RECAT amendment safety assessment

RECAT A & B - Heavy-Heavy pairs

		S	H	
		A	B	C
S	A			
H	B		3.0	4.0
	C		2.5	2.5

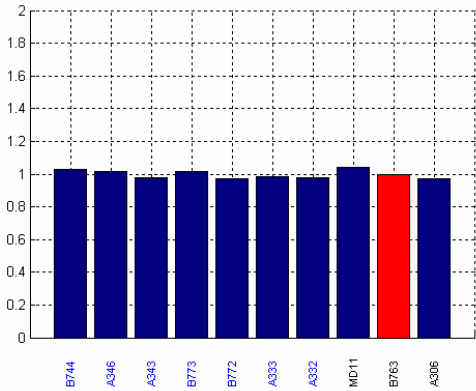


# RECAT amendment safety assessment

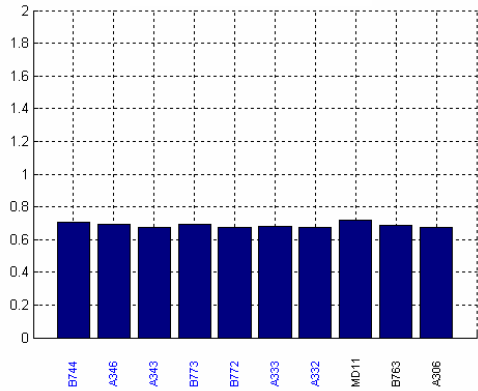
ICAO - Heavy-Heavy pairs

ICAO		S			H			M		L
		A	B	C	D	E	F			
S	A									
	B		4.0	4.0	5.0	5.0	6.0			
H	C		4.0	4.0	5.0	5.0	6.0			
	D		2.5	2.5	2.5	2.5	5.0			
M	E		2.5	2.5	2.5	2.5	5.0			
	F		2.5	2.5	2.5	2.5	2.5			

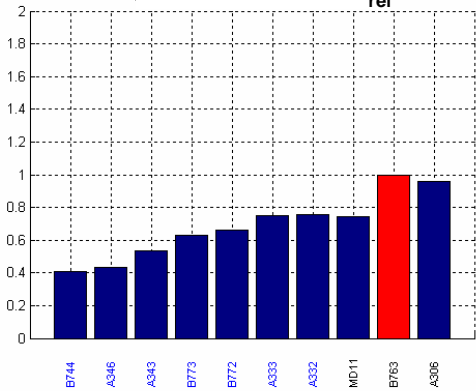
Circulation : CAT B<sub>ref</sub> – Heavy



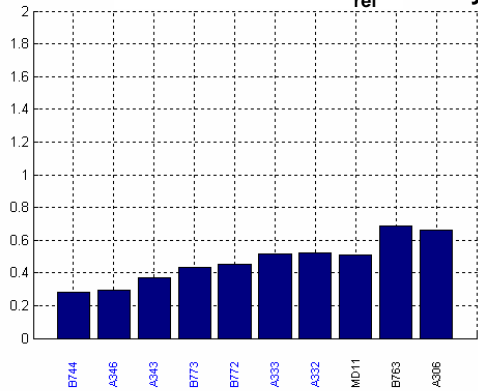
Circulation : CAT C<sub>ref</sub> – Heavy



Roll Acceleration : CAT B<sub>ref</sub> – Heavy



Roll Acceleration : CAT C<sub>ref</sub> – Heavy



Roll Acceleration

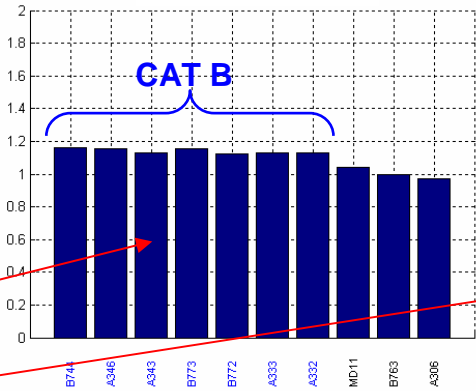


# RECAT amendment safety assessment

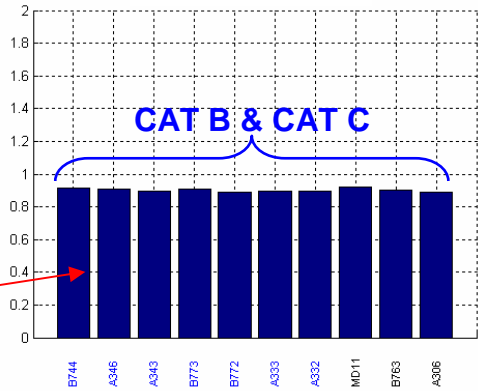
## RECAT A & B - Heavy-Heavy pairs

RECAT A/B	S		H			M		L
	A	B	C	D	E	F		
S	A							
H	B		3.0	4.0	5.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

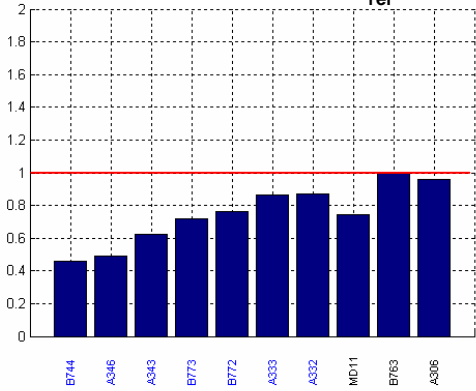
Circulation : CAT B<sub>ref</sub> – Heavy



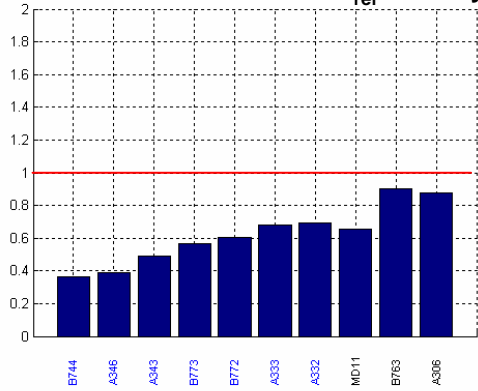
Circulation : CAT C<sub>ref</sub> – Heavy



Roll Acceleration : CAT B<sub>ref</sub> – Heavy



Roll Acceleration : CAT C<sub>ref</sub> – Heavy



Roll  
Acceleration

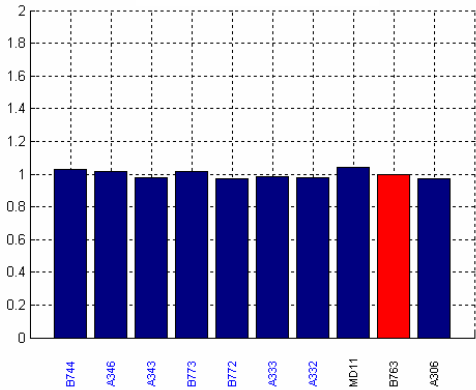


# RECAT amendment safety assessment

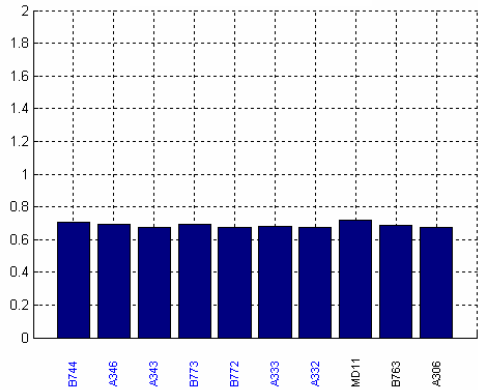
ICAO - Heavy-Heavy pairs

ICAO		S			H			M		L
		A	B	C	D	E	F			
S	A									
	B		4.0	4.0	5.0	5.0	6.0			
H	C		4.0	4.0	5.0	5.0	6.0			
	D		2.5	2.5	2.5	2.5	5.0			
M	E		2.5	2.5	2.5	2.5	5.0			
	F		2.5	2.5	2.5	2.5	2.5			

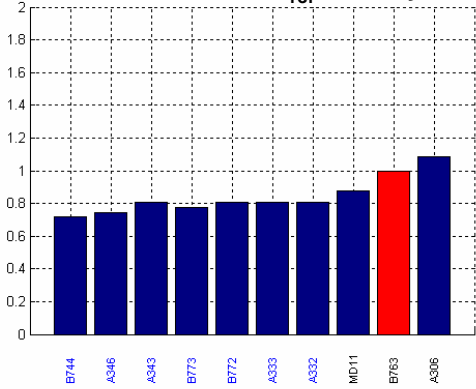
Circulation : CAT B<sub>ref</sub> – Heavy



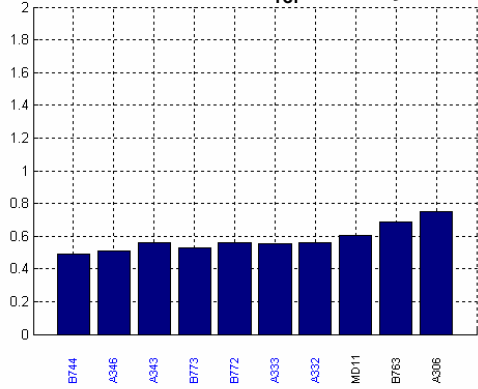
Circulation : CAT C<sub>ref</sub> – Heavy



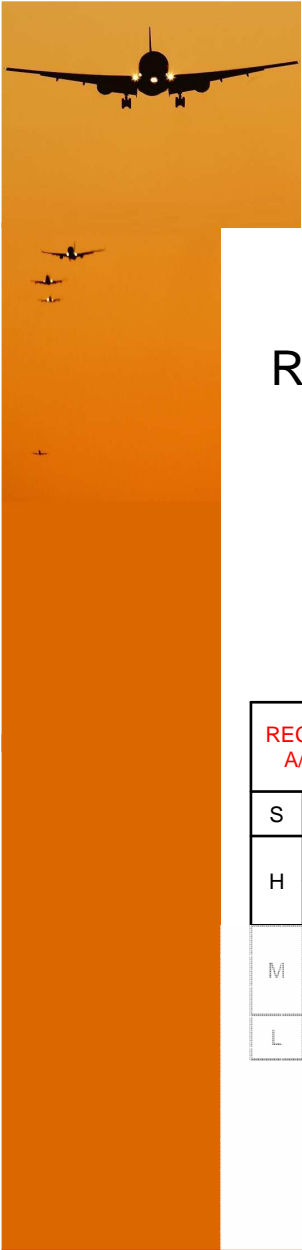
RMC : CAT B<sub>ref</sub> – Heavy



RMC : CAT C<sub>ref</sub> – Heavy



Rolling  
Moment  
Coefficient

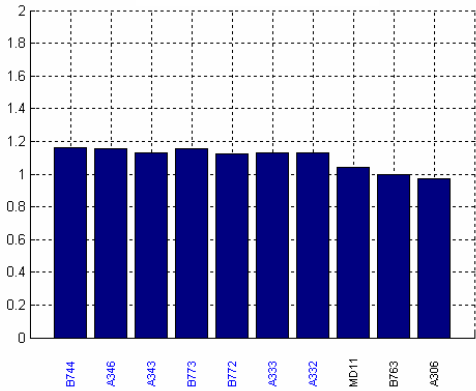


# RECAT amendment safety assessment

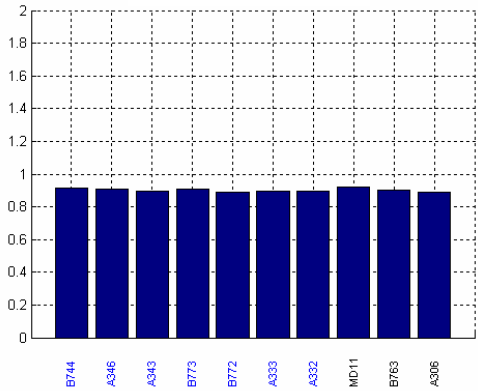
## RECAT A & B - Heavy-Heavy pairs

RECAT A/B		S			H			M		L
		A	B	C	D	E	F			
S	A									
	B		3.0	4.0	5.0	5.0	7.0			
H	C		2.5	2.5	3.5	3.5	6.0			
	D				2.5	2.5	2.5	2.5	5.0	
M	E				2.5	2.5	2.5	2.5	4.0	
	F				2.5	2.5	2.5	2.5	2.5	
L	F				2.5	2.5	2.5	2.5	2.5	

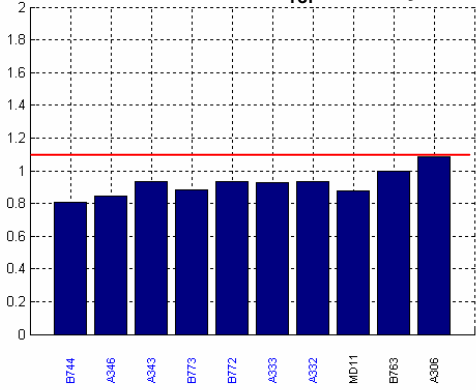
Circulation : CAT B<sub>ref</sub> – Heavy



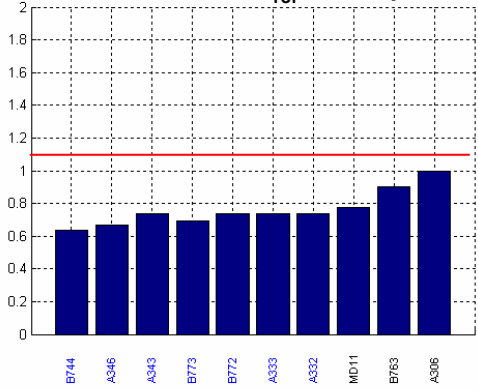
Circulation : CAT C<sub>ref</sub> – Heavy



RMC : CAT B<sub>ref</sub> – Heavy



RMC : CAT C<sub>ref</sub> – Heavy



Rolling  
Moment  
Coefficient



# RECAT amendment safety assessment

## Preliminary Conclusion

Heavy – Heavy

RECAT A proposal confirmed  
to be acceptably safe



# RECAT amendment safety assessment

Heavy - Medium





# RECAT amendment safety assessment

ICAO - Heavy-Medium pairs

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		4.0	4.0	5.0	5.0	6.0
	C		4.0	4.0	5.0	5.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	5.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT amendment safety assessment

## RECAT A - Heavy-Medium pairs

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		<b>3.0</b>	4.0	5.0	5.0	<b>7.0</b>
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT amendment safety assessment

## RECAT B.1 - Heavy-Medium pairs

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.5	3.5	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5

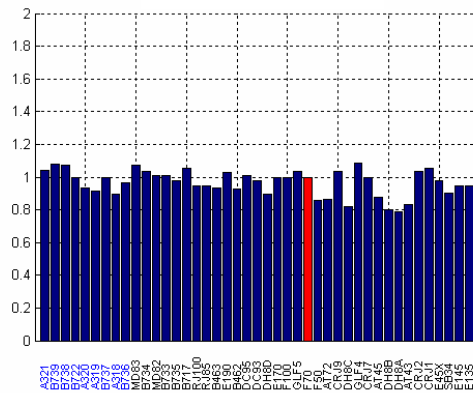


# RECAT amendment safety assessment

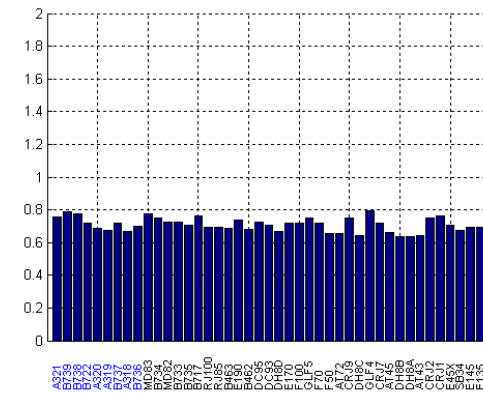
ICAO - Heavy-Medium pairs

ICAO	S		H		M		L
	A	B	C	D	E	F	
S	A						
H	B		4.0	4.0	5.0	5.0	6.0
	C		4.0	4.0	5.0	5.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	5.0
L	F		2.5	2.5	2.5	2.5	2.5

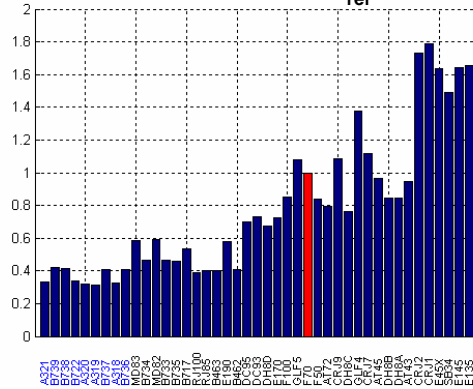
Circulation : CAT B<sub>ref</sub> – Medium



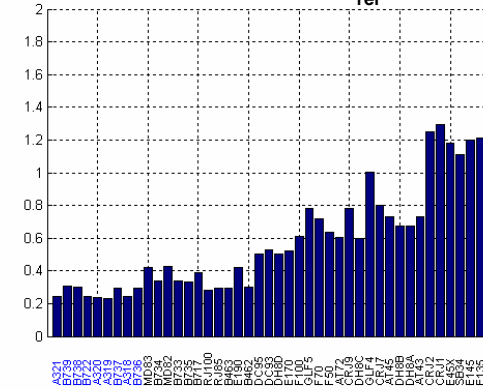
Circulation : CAT C<sub>ref</sub> – Medium



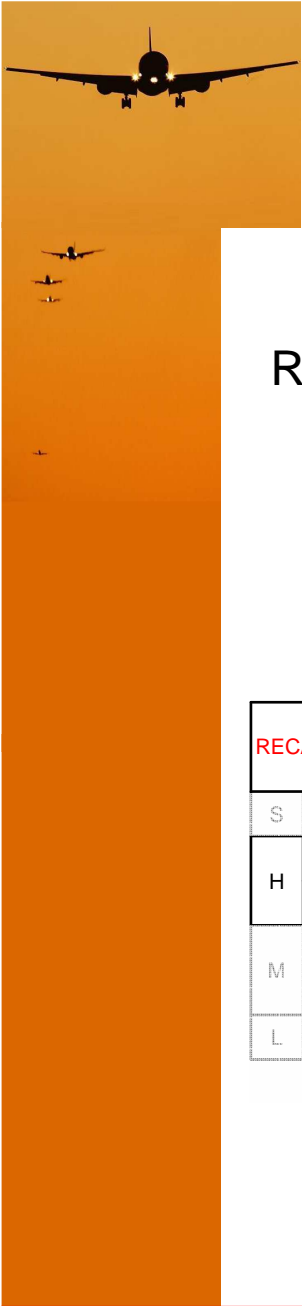
Roll Acceleration : CAT B<sub>ref</sub> – Medium



Roll Acceleration : CAT C<sub>ref</sub> – Medium



Roll  
Acceleration

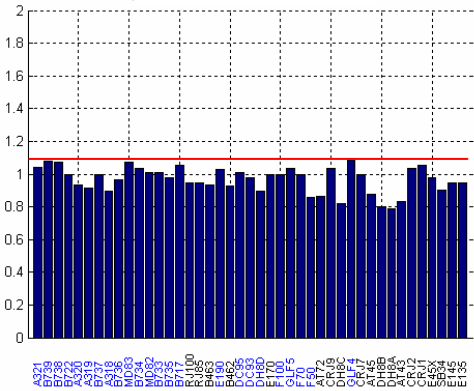


# RECAT amendment safety assessment

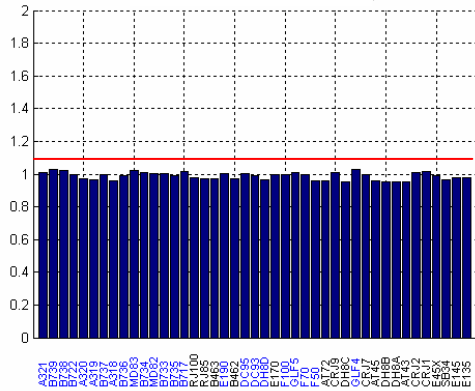
## RECAT A - Heavy-Medium pairs

RECAT A		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	5.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

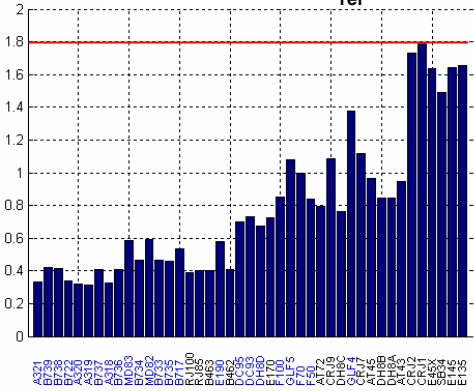
Circulation : CAT B<sub>ref</sub> – Medium



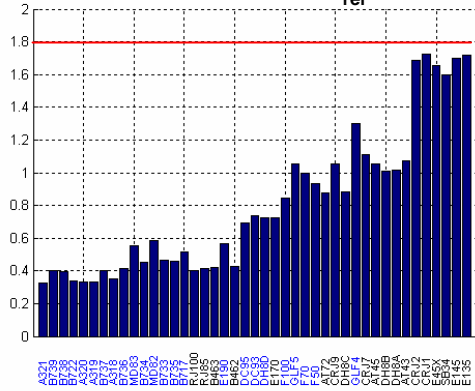
Circulation : CAT C<sub>ref</sub> – Medium



Roll Acceleration : CAT B<sub>ref</sub> – Medium



Roll Acceleration : CAT C<sub>ref</sub> – Medium



Roll  
Acceleration

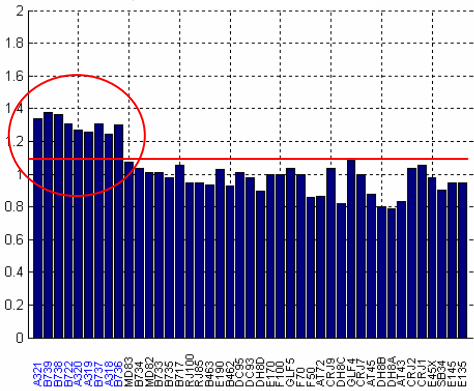


# RECAT amendment safety assessment

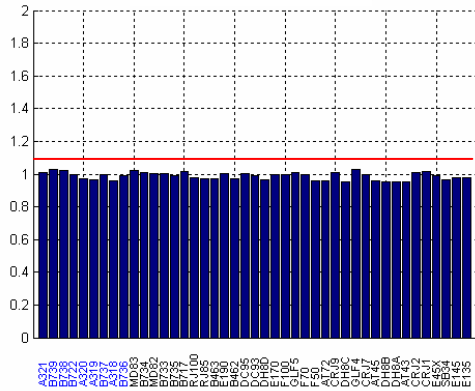
## RECAT B.1 - Heavy-Medium

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	4.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

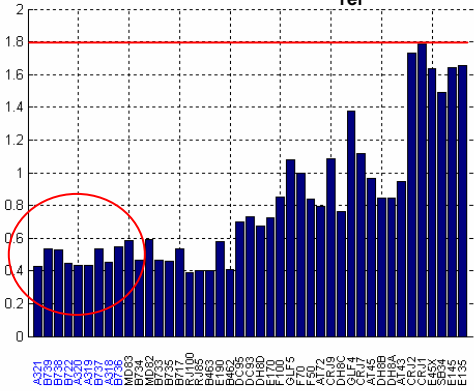
Circulation : CAT B<sub>ref</sub> – Medium



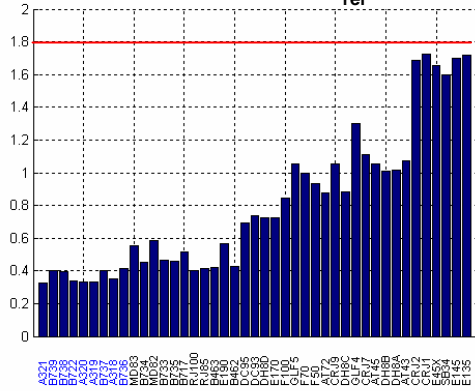
Circulation : CAT C<sub>ref</sub> – Medium



Roll Acceleration : CAT B<sub>ref</sub> – Medium



Roll Acceleration : CAT C<sub>ref</sub> – Medium



Roll Acceleration

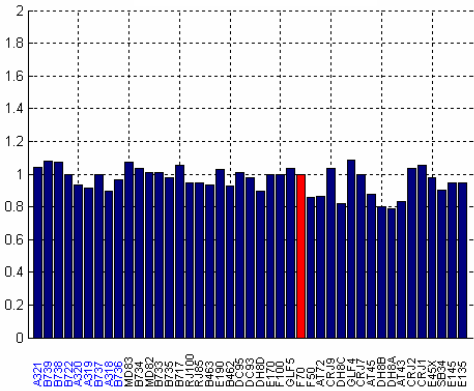


# RECAT amendment safety assessment

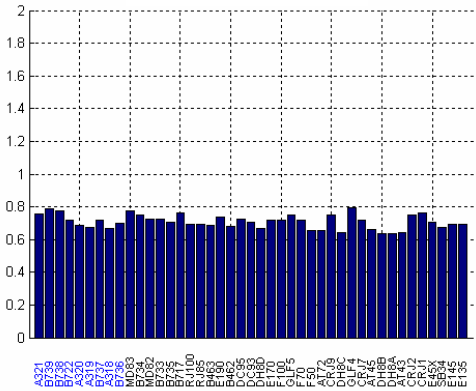
## ICAO - Heavy-Medium pairs

ICAO		S			H		M		L
		A	B	C	D	E	F		
S	A								
	B		4.0	4.0	5.0	5.0	6.0		
H	C		4.0	4.0	5.0	5.0	6.0		
	D		2.5	2.5	2.5	2.5	5.0		
M	E		2.5	2.5	2.5	2.5	5.0		
	F		2.5	2.5	2.5	2.5	2.5		

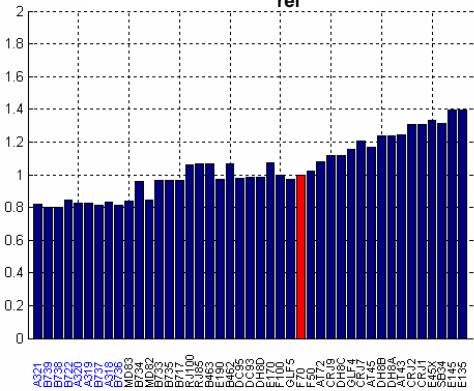
Circulation : CAT B<sub>ref</sub> – Medium



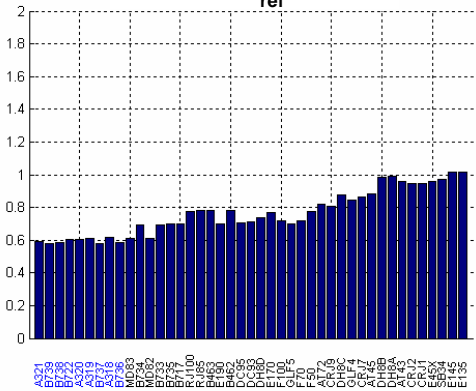
Circulation : CAT C<sub>ref</sub> – Medium



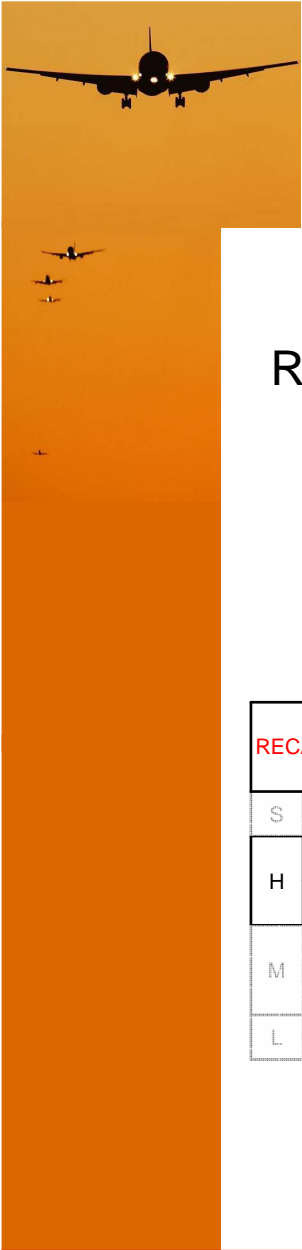
RMC : CAT B<sub>ref</sub> – Medium



RMC : CAT C<sub>ref</sub> – Medium



Rolling  
Moment  
Coefficient



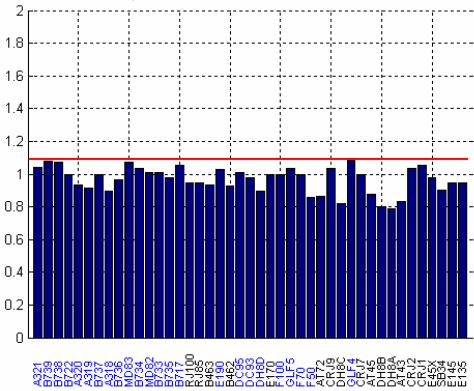
# RECAT amendment safety assessment

## RECAT A - Heavy-Medium pairs

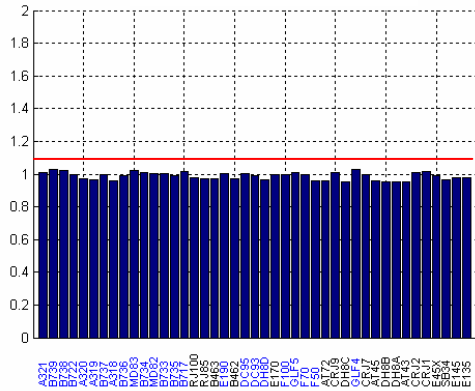
RECAT A		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	5.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

Rolling Moment Coefficient

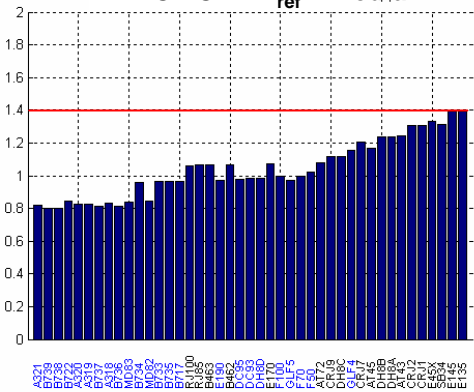
Circulation : CAT B<sub>ref</sub> – Medium



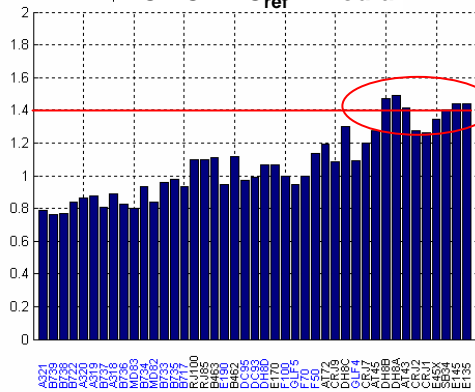
Circulation : CAT C<sub>ref</sub> – Medium



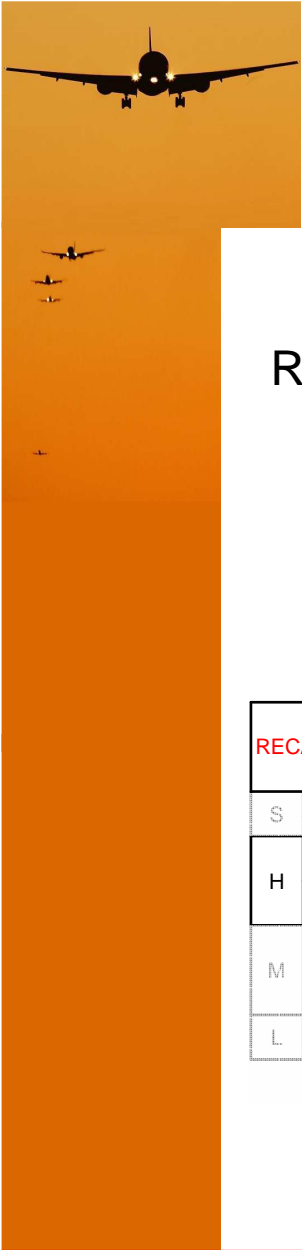
RMC : CAT B<sub>ref</sub> – Medium



RMC : CAT C<sub>ref</sub> – Medium





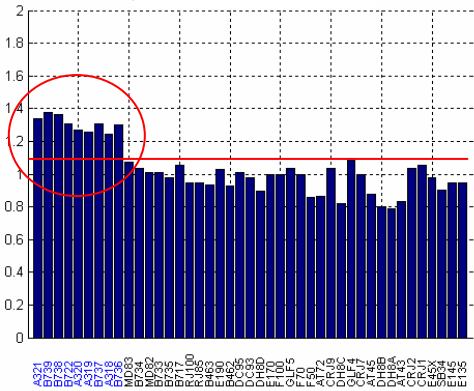


# RECAT amendment safety assessment

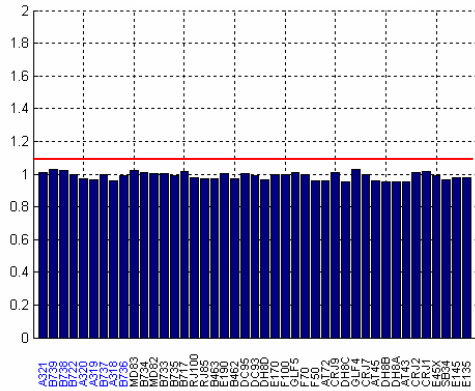
## RECAT B.1 - Heavy-Medium pairs

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	4.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

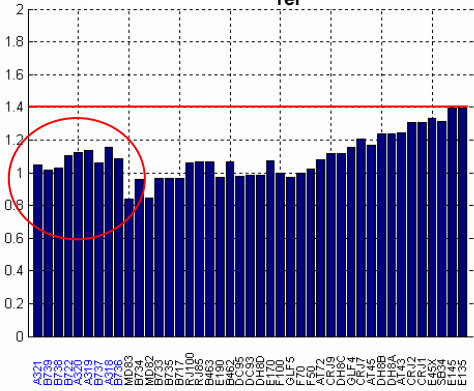
Circulation : CAT B<sub>ref</sub> – Medium



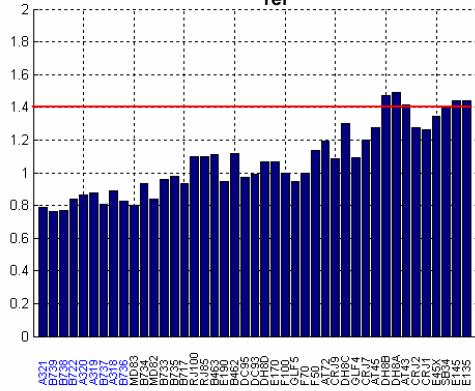
Circulation : CAT C<sub>ref</sub> – Medium



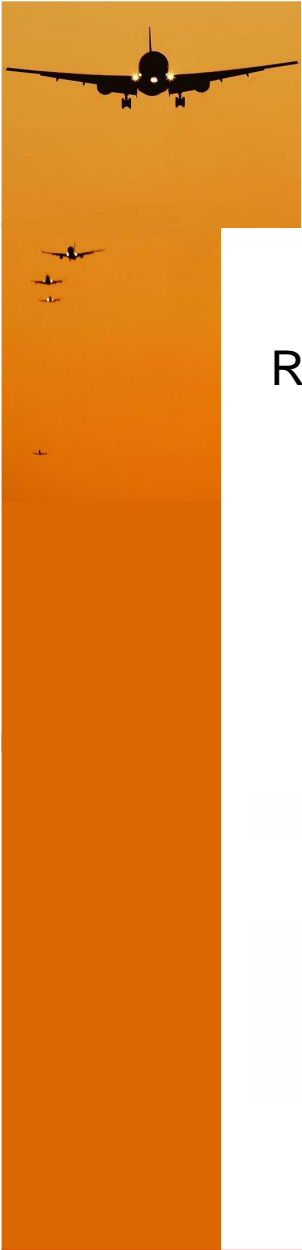
RMC : CAT B<sub>ref</sub> – Medium



RMC : CAT C<sub>ref</sub> – Medium



Rolling  
Moment  
Coefficient



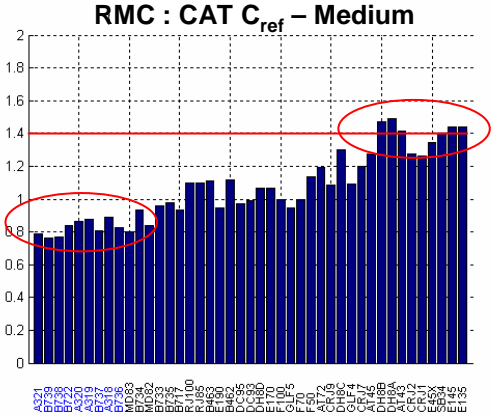
# RECAT amendment safety assessment

RECAT B.1 - Heavy-Medium pairs

$$\text{Rolling Moment Coefficient} \propto \frac{\Gamma_i}{V_{f_j} \cdot b_{f_j}}$$

Ac Type	Span [m]	App. Speed [kt]
DH8A	25.9	86
DH8B	25.9	87
AT43	24.6	95

CRJ2	21.2	130
AT72	27.1	103



Rolling  
Moment  
Coefficient



# RECAT amendment safety assessment

## RECAT B.1 - Heavy-Medium pairs

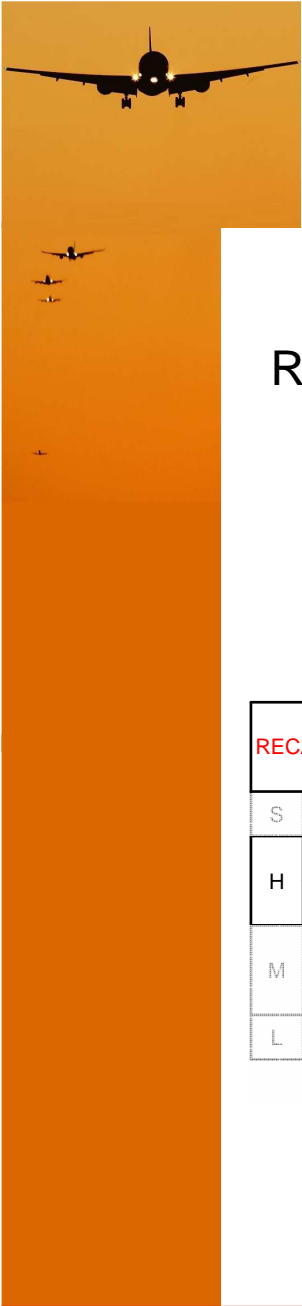
		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.5	3.5	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT amendment safety assessment

## RECAT B.2 - Heavy-Medium pairs

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.0	4.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5

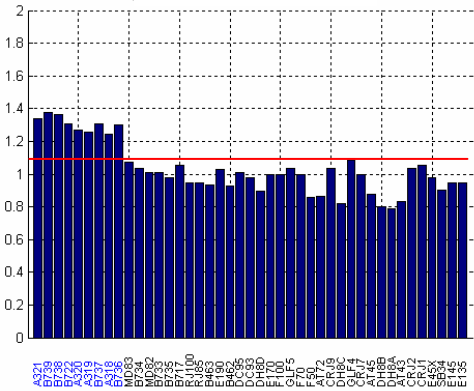


# RECAT amendment safety assessment

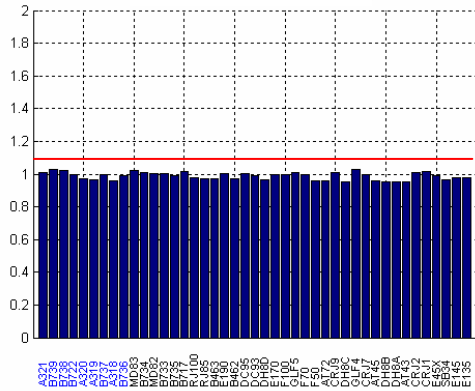
## RECAT B.1 - Heavy-Medium

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
	B		3.0	4.0	4.0	5.0	7.0	
H	C		2.5	2.5	3.5	3.5	6.0	
	D		2.5	2.5	2.5	2.5	5.0	
M	E		2.5	2.5	2.5	2.5	4.0	
	F		2.5	2.5	2.5	2.5	2.5	

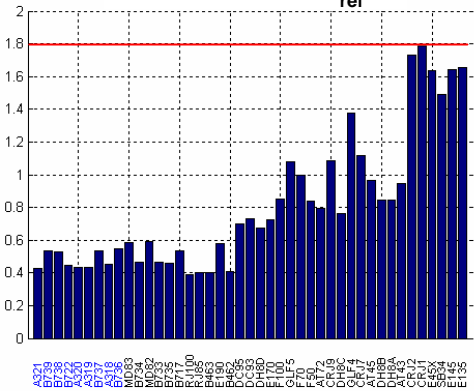
Circulation : CAT B<sub>ref</sub> – Medium



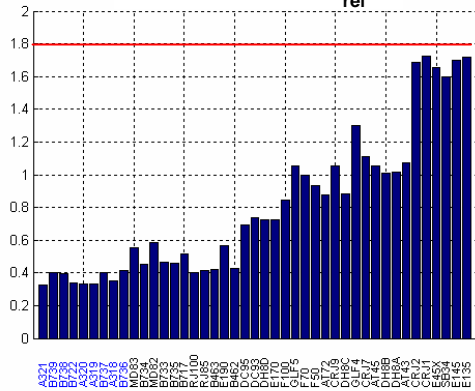
Circulation : CAT C<sub>ref</sub> – Medium



Roll Acceleration : CAT B<sub>ref</sub> – Medium



Roll Acceleration : CAT C<sub>ref</sub> – Medium



Roll  
Acceleration

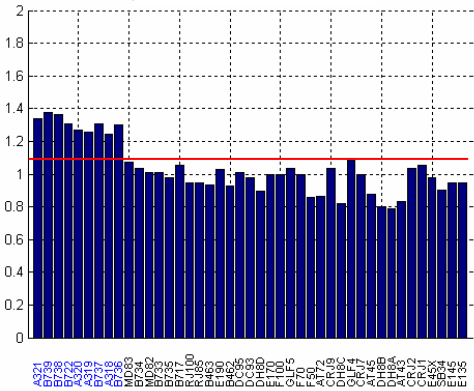


# RECAT amendment safety assessment

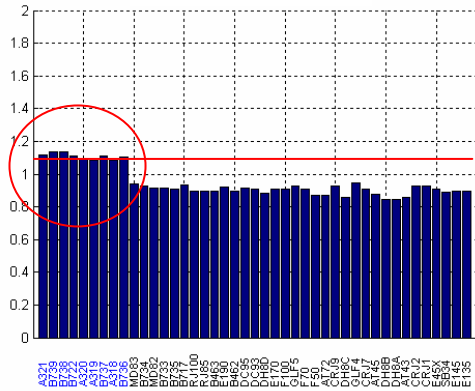
## RECAT B.2 - Heavy-Medium

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	4.0	5.0	7.0	
	C		2.5	2.5	3.0	4.0	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

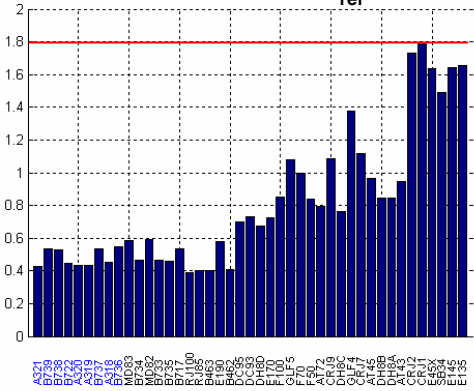
Circulation : CAT B<sub>ref</sub> – Medium



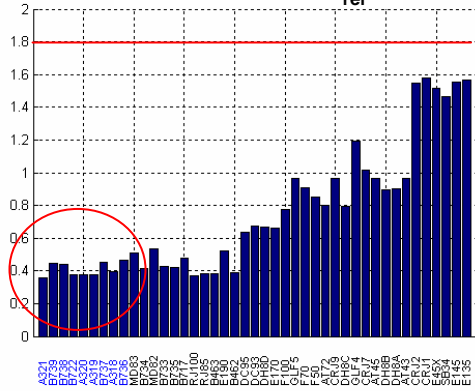
Circulation : CAT C<sub>ref</sub> – Medium



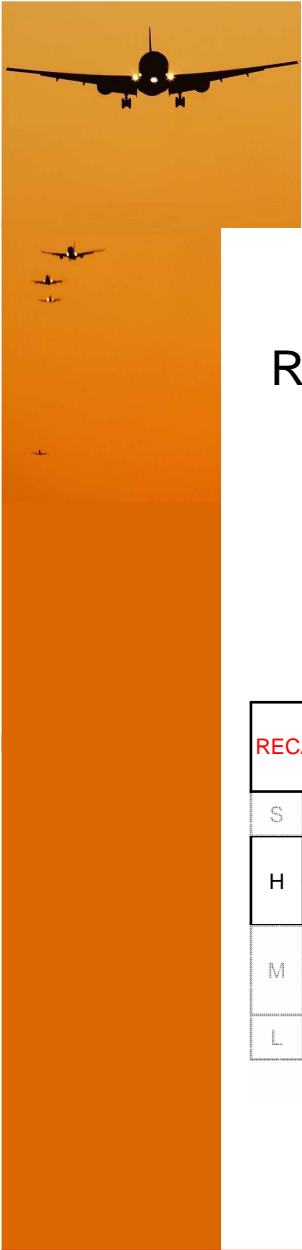
Roll Acceleration : CAT B<sub>ref</sub> – Medium



Roll Acceleration : CAT C<sub>ref</sub> – Medium



Roll Acceleration

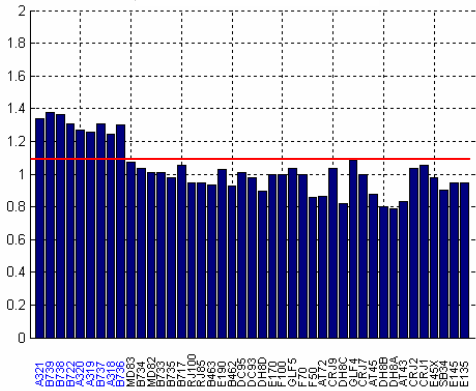


# RECAT amendment safety assessment

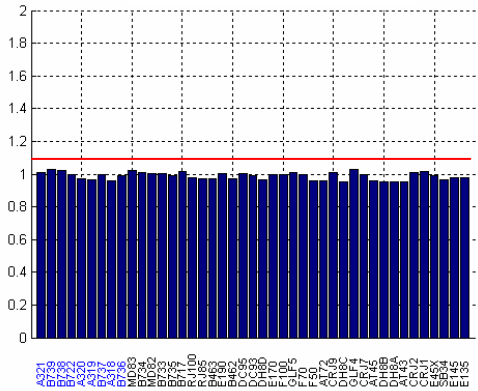
## RECAT B.1 - Heavy-Medium pairs

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
H	B		3.0	4.0	4.0	5.0	7.0	
	C		2.5	2.5	3.5	3.5	6.0	
M	D		2.5	2.5	2.5	2.5	5.0	
	E		2.5	2.5	2.5	2.5	4.0	
L	F		2.5	2.5	2.5	2.5	2.5	

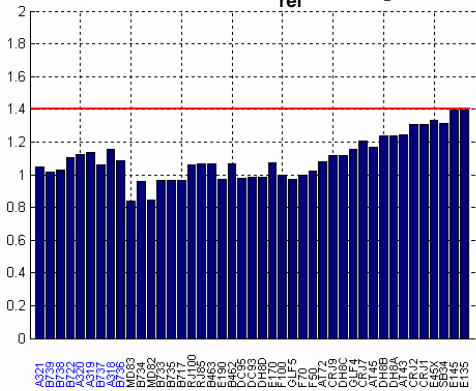
Circulation : CAT B<sub>ref</sub> – Medium



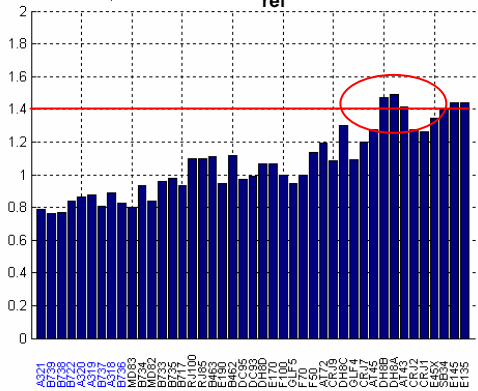
Circulation : CAT C<sub>ref</sub> – Medium



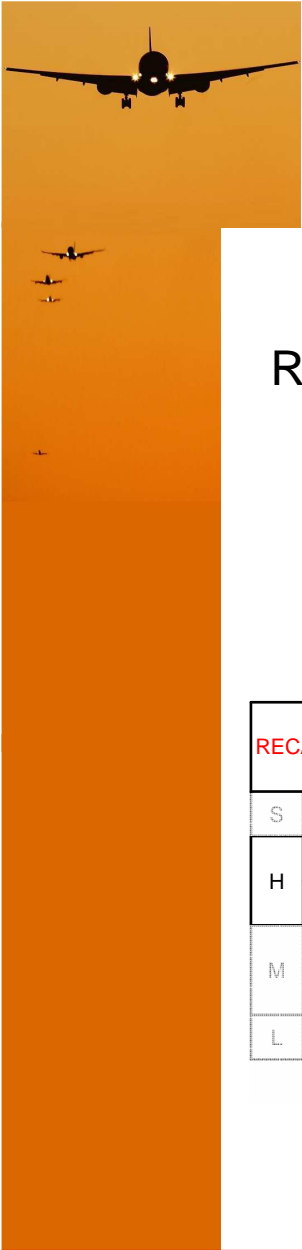
RMC : CAT B<sub>ref</sub> – Medium



RMC : CAT C<sub>ref</sub> – Medium



Rolling  
Moment  
Coefficient

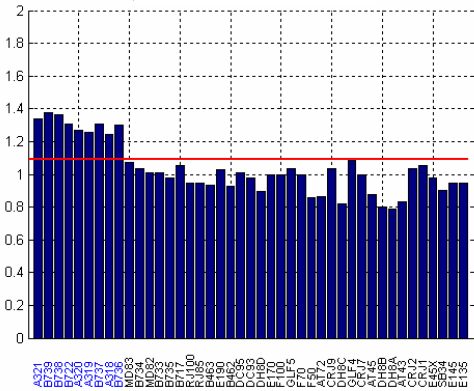


# RECAT amendment safety assessment

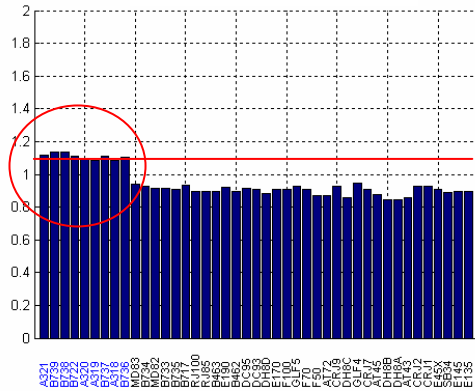
## RECAT B.2 - Heavy-Medium pairs

RECAT B		S		H		M		L
		A	B	C	D	E	F	
S	A							
	B		3.0	4.0	4.0	5.0	7.0	
H	C		2.5	2.5	3.0	4.0	6.0	
	D		2.5	2.5	2.5	2.5	5.0	
M	E		2.5	2.5	2.5	2.5	4.0	
	F		2.5	2.5	2.5	2.5	2.5	

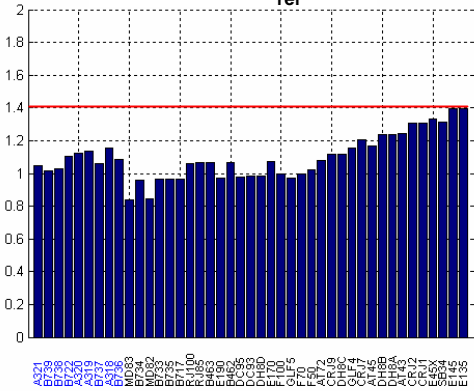
Circulation : CAT B<sub>ref</sub> – Medium



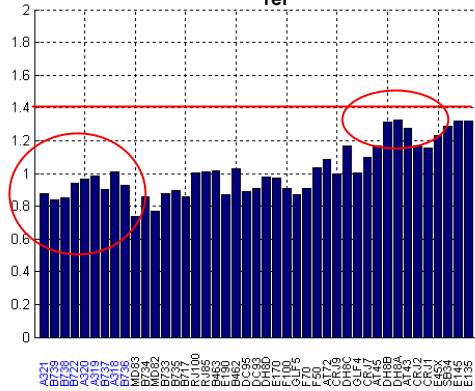
Circulation : CAT C<sub>ref</sub> – Medium



RMC : CAT B<sub>ref</sub> – Medium



RMC : CAT C<sub>ref</sub> – Medium



Rolling  
Moment  
Coefficient





# RECAT amendment safety assessment

## Preliminary Conclusion

Heavy – Medium

RECAT B proposal confirmed  
to be acceptably safe

- Reduction of CAT B – CAT D
- Slight reduction of CAT C – CAT D
- Slight increase of CAT C – CAT E



# RECAT amendment proposal

RECAT A

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		<b>3.0</b>	4.0	5.0	5.0	<b>7.0</b>
	C		<b>2.5</b>	<b>2.5</b>	<b>3.5</b>	<b>3.5</b>	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



# RECAT amendment proposal

## RECAT B

		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.0	4.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5

ICAO separation

**RECAT A separation reduction**

**RECAT B separation reduction**

**RECAT B limited separation reduction compared to RECAT A**

**RECAT A separation increase**



# RECAT amendment capacity assessment

Basic impact assessment based on real traffic (landing time) and conducted by EUROCONTROL for:

- LFPG
- EGLL
- EDDF

Very similar results for all 3 airports in terms of capacity



# RECAT amendment capacity assessment

## Logic of the impact assessment:

Only pairs with separation  $<$  ICAO separation + 1Nm are reduced

B744 – A320 @ 6.5Nm is not reduced by RECAT

B744 – A320 @ 5.5Nm is reduced

Reduction applied on the real separation

B744 – A320 @ 5.5Nm is reduced to 4.5Nm

Reduction not allowed below RECAT separation

B744 – A320 @ 4.8Nm is not reduced to 3.8Nm

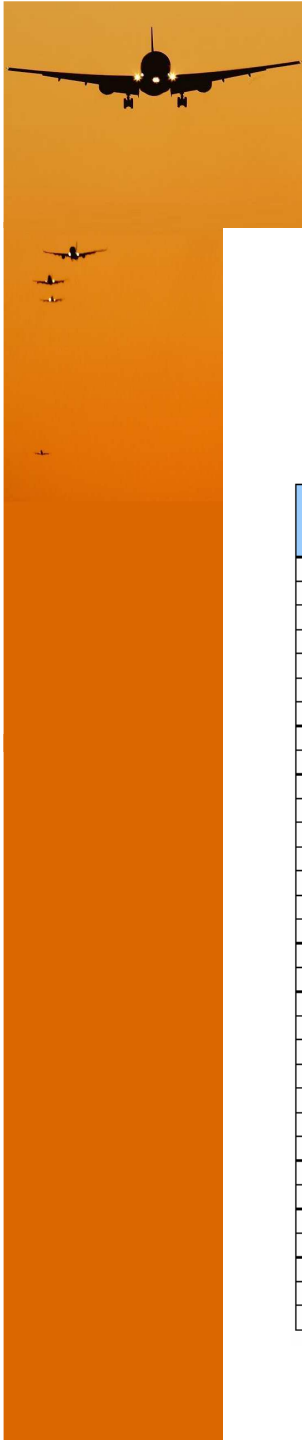
B744 – A320 @ 4.8Nm is reduced to 4.0Nm

Number of Nm saved per day are summed

B744 – A320 @ 4.8Nm reduced @ 4.0Nm contribute to save 0.8Nm

Number of additional slots is derived considering one slot = 3Nm

If 30Nm are saved along a day, number of potential additional slot = 10

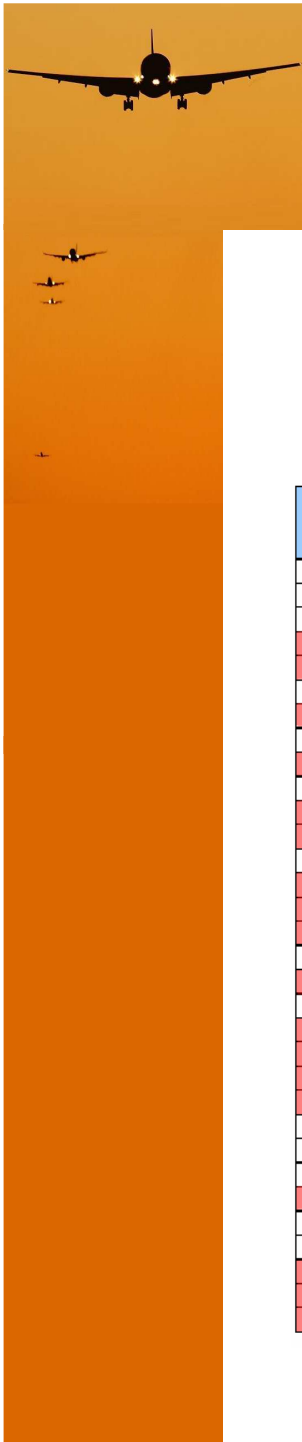


# RECAT amendment capacity assessment

LFPG – Capacity assessment on a particular day

Ac type leader	Ac type follower	Theoretical ICAO separation	Proposed RECAT 1 separation
A343	B744	4	3
B762	A320	5	3.5
A332	A332	4	3
B772	B772	4	3
B772	A332	4	3
B763	A321	5	3.5
B772	A343	4	3
B772	A321	5	5
B752	B773	4	2.5
B773	A321	5	5
B752	B737	5	2.5
A332	A332	4	3
A343	B772	4	3
B772	A343	4	3
A332	B772	4	3
B773	A343	4	3

Ac type leader	Ac type follower	Theoretical ICAO separation	Proposed RECAT 1 separation
B763	CRJ7	5	3.5
B772	B773	4	3
B752	CRJ7	5	2.5
A343	B772	4	3
B753	A320	5	2.5
A332	A332	4	3
B772	A343	4	3
B772	B744	4	3
A332	B744	4	3
B763	CRJ7	5	3.5
B752	A320	5	2.5
B762	A320	5	3.5
A30B	A318	5	3.5
B753	E190	5	2.5
MD11	B733	5	3.5
B762	A321	5	3.5



# RECAT amendment capacity assessment

LFPG – Capacity assessment on a particular day

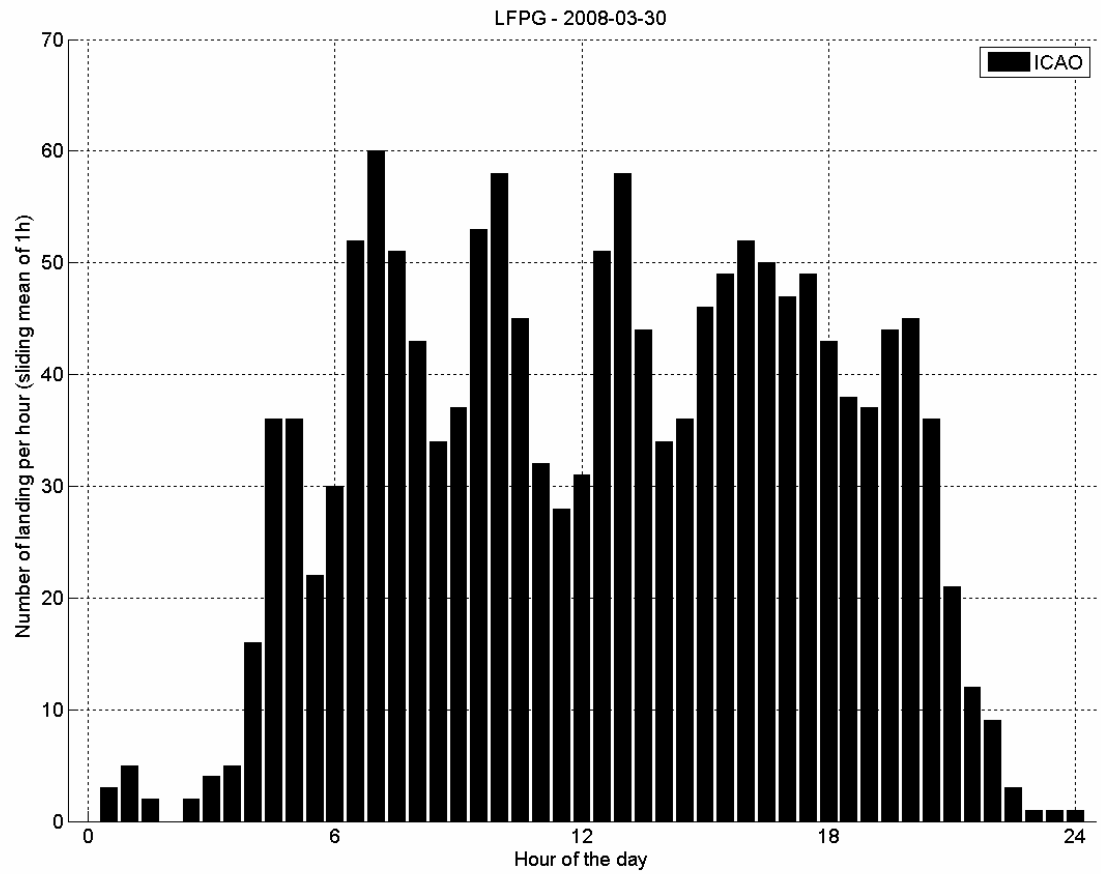
Ac type leader	Ac type follower	Theoretical ICAO separation	Proposed RECAT 1 separation	Proposed RECAT 2 separation
A343	B744	4	3	3
B762	A320	5	3.5	3.5
A332	A332	4	3	3
B772	A319	5	5	4
B772	B739	5	5	4
B772	B772	4	3	3
B772	A320	5	5	4
B772	A332	4	3	3
A343	A320	5	5	4
B763	A321	5	3.5	3.5
B744	A321	5	5	4
A332	A319	5	5	4
B772	A343	4	3	3
A343	A318	5	5	4
A343	A320	5	5	4
B772	A321	5	5	4
B752	B773	4	2.5	2.5
B773	A321	5	5	4
B752	B737	5	2.5	2.5
B773	A321	5	5	4
A343	B738	5	5	4
B744	A319	5	5	4
A332	A320	5	5	4
A332	A332	4	3	3
A343	B772	4	3	3
B772	A343	4	3	3
A343	A320	5	5	4
A332	B772	4	3	3
B773	A343	4	3	3
A343	A320	5	5	4
A343	A320	5	5	4
B744	A319	5	5	4

Ac type leader	Ac type follower	Theoretical ICAO separation	Proposed RECAT 1 separation	Proposed RECAT 2 separation
B763	CRJ7	5	3.5	3.5
B772	B773	4	3	3
B752	CRJ7	5	2.5	2.5
B744	A321	5	5	4
A343	B772	4	3	3
B772	A319	5	5	4
B753	A320	5	2.5	3.5
B773	A320	5	5	4
B744	A318	5	5	4
B773	A320	5	5	4
A343	A320	5	5	4
A343	A320	5	5	4
B744	A320	5	5	4
A332	A332	4	3	3
A332	A318	5	5	4
A332	A319	5	5	4
B744	A319	5	5	4
B772	A343	4	3	3
A343	A318	5	5	4
B772	A321	5	5	4
A332	A321	5	5	4
B772	B744	4	3	3
A332	B744	4	3	3
B763	CRJ7	5	3.5	3.5
B752	A320	5	2.5	3.5
B762	A320	5	3.5	3.5
A30B	A318	5	3.5	3.5
B753	E190	5	2.5	3.5
B772	A318	5	5	4
MD11	B733	5	3.5	3.5
B762	A321	5	3.5	3.5



# RECAT amendment capacity assessment

LFPG – ICAO

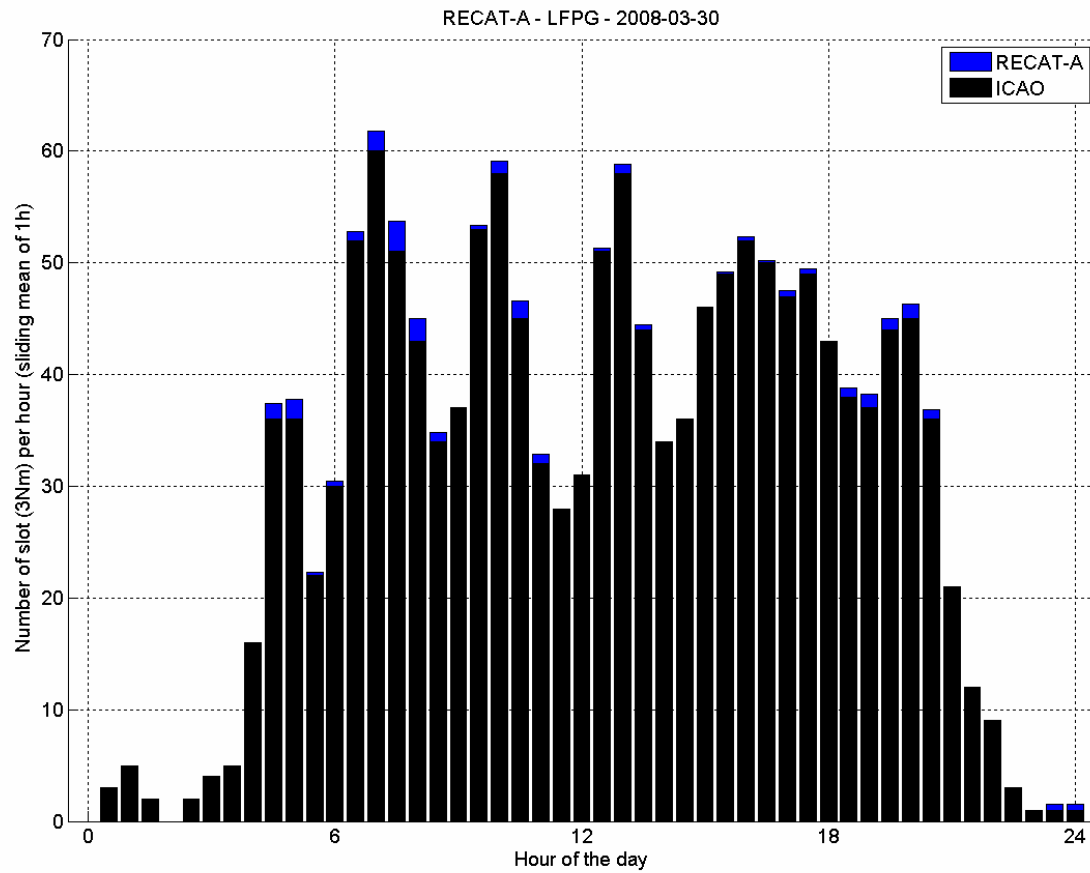






# RECAT amendment capacity assessment

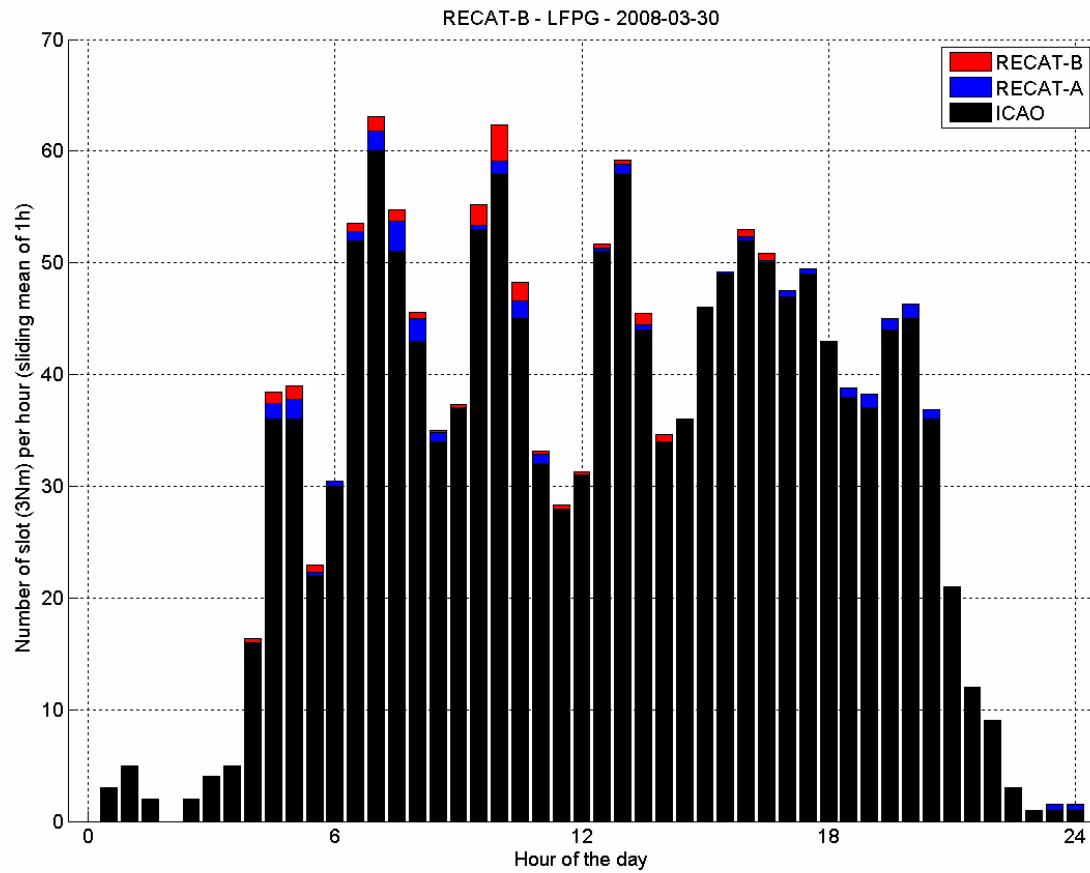
LFPG – RECAT A

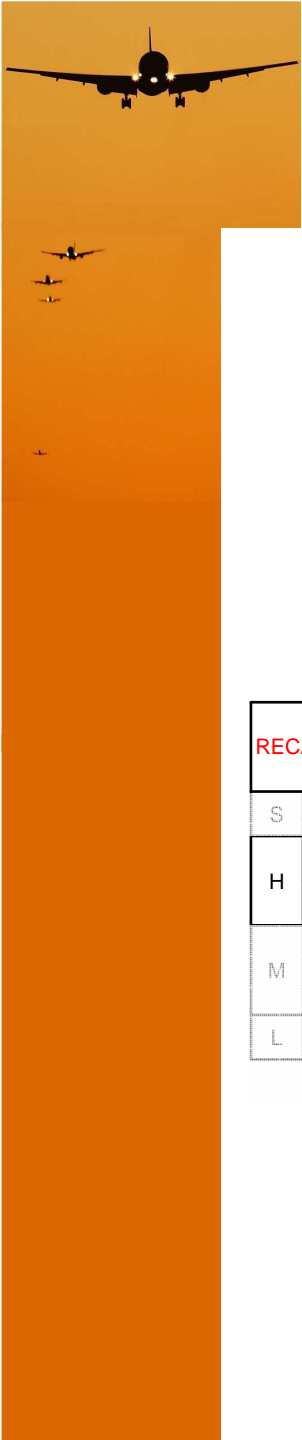




# RECAT amendment capacity assessment

LFPG – RECAT B.1





# RECAT amendment capacity assessment

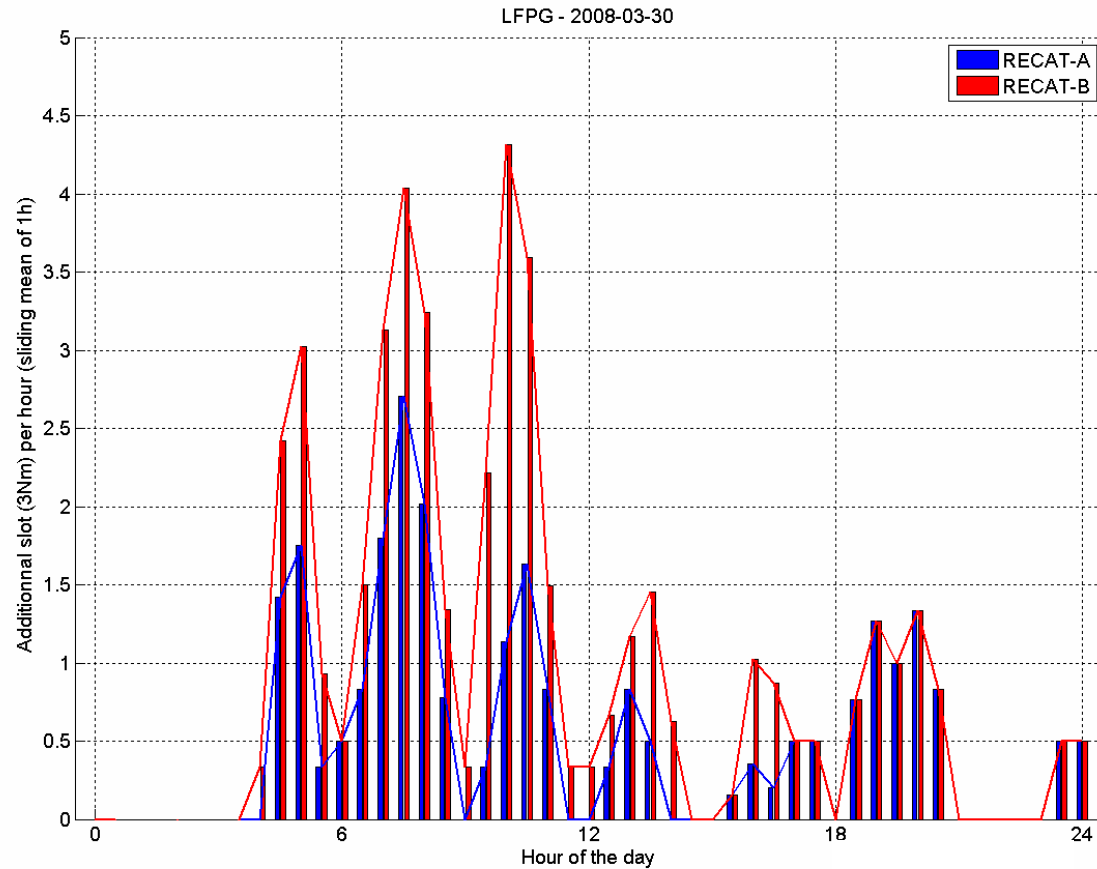
LFPG – RECAT B.1

Capacity benefit:

RECAT A : 1.5% (11 slots)

RECAT B.1 : 2.9% (21 slots)

RECAT B		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.5	3.5	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5





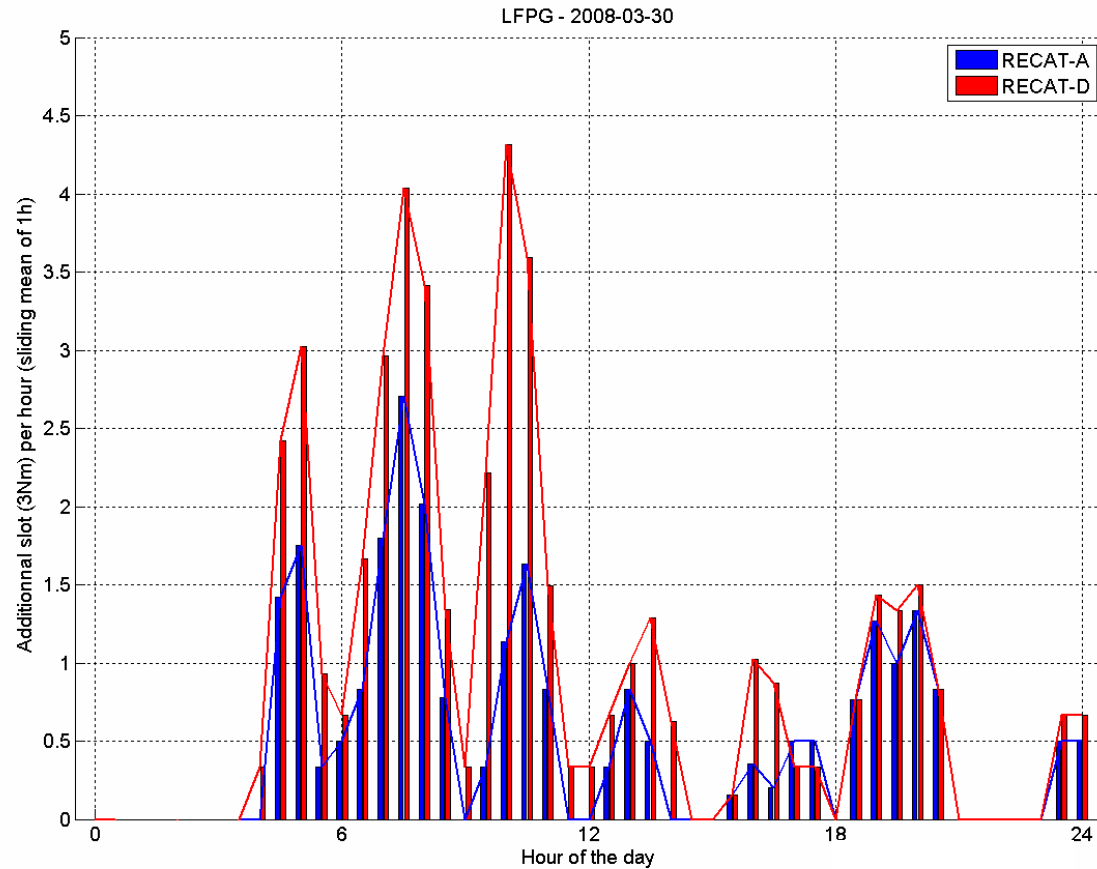
# RECAT amendment capacity assessment

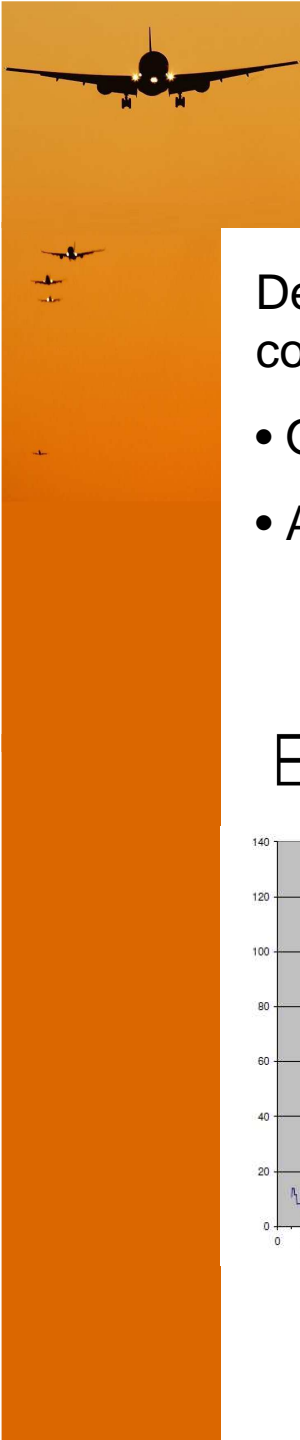
## LFPG – RECAT B.2

### Capacity benefit:

- RECAT A : 1.5% (11 slots)
- RECAT B.1 : 2.9% (21 slots)
- RECAT B.2 : 2.9% (22 slots)

RECAT B		S	H		M		L
		A	B	C	D	E	F
S	A						
H	B		3.0	4.0	4.0	5.0	7.0
	C		2.5	2.5	3.0	4.0	6.0
M	D		2.5	2.5	2.5	2.5	5.0
	E		2.5	2.5	2.5	2.5	4.0
L	F		2.5	2.5	2.5	2.5	2.5



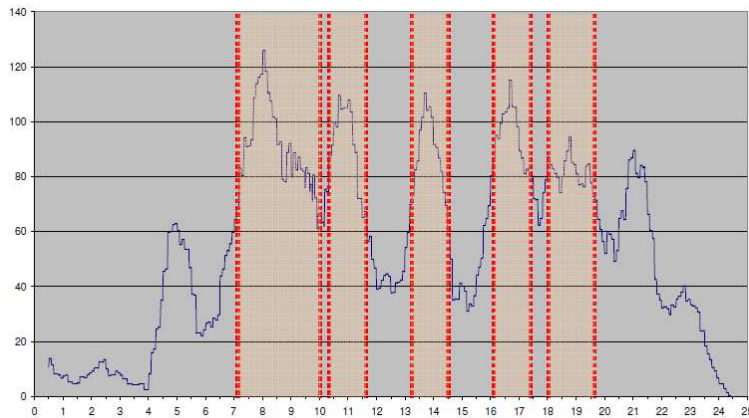


# RECAT amendment capacity assessment

Detailed impact assessment based on local capacity assessment tools and conducted by ANSP:

- Ongoing NATS analysis for EGLL
- Available from DGAC for LFPG

	Plage 1	Plage 2	Plage 3	Plage 4	Plage 5
Debut	7h00	10h20	13h20	16h00	18h00
Fin	10h00	11h20	14h20	17h30	19h30



Capacity benefit:

RECAT A : 1.5% (11 slots)  
 RECAT B.1 : 2.9% (21 slots)

Peak Hour	RECAT A	RECAT A (future)	RECAT B.1
1	1.26%	0.8%	5.5%
2	1.23%	0.4%	2.9%
3	0.06%	0.4%	1.3%
4	3.34%	1.4%	5.7%
5	0.61%	0.1%	1.4%
<b>Mean</b>	<b>1.26%</b>	<b>0.6%</b>	<b>3.3%</b>

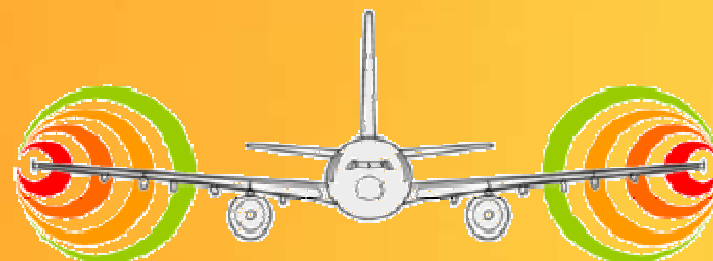


# Next steps

1. Kick-off meeting with the key European partners
2. Agreement on a planning for
  - preparing a new RECAT proposal
  - preparing the associated safety case
  - Conduct the capacity assessment
3. Significant EUROCONTROL effort will be dedicated to the European RECAT amendment during the next 6 months
4. Time horizon for completion : September 2012



# Question?



**WakeNet3-Europe**  
*A network on Aircraft Wake Turbulence*