

Approach and Departure Optimised **Wake Turbulence** Re-Categorisation and **Pair-Wise Separation** minima

RECAT-EU-PWS scheme



Supported by SESAR JU and developed in partnership with



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"RECAT-EU-PWS" Solution					
Optimised Wake Turbulence Categorisation and static Pair-Wise Separation (S-PWS) Minima on Approach and Departure					
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Abstract					
<p>This document presents the European Optimised Wake Turbulence Categorisation and static Pair-Wise Separation (S-PWS) Minima for Approach and Departure phases of flight, also named 'RECAT-EU-PWS' scheme.</p> <p>The 'S-PWS' solution for Approach (Distance minima) and Departure (Distance and Time minima), developed under the SESAR2020 programme as PJ02.01.04 (S-PWS-A) and PJ02.01.06 (S-PWS-D), is a refinement from RECAT-EU, delivering further separation reduction for some frequent aircraft pairs, and supporting increased runway throughput.</p> <p>The minima are derived on the basis of the same methodology as used in RECAT-EU (previously endorsed by EASA), aligning the wake turbulence encounter risk on a pair-wise basis. These minima are supported by a 'generic' Safety Case produced by EUROCONTROL and submitted to EASA for review and recommendations, in support of regulatory acceptance of local deployments.</p> <p>There are several ways to operate the RECAT-EU-PWS scheme: on a pair-wise basis (with ATC separation delivery tool support), on a categorical system basis (with/without ATC separation delivery tool support), or on a procedural basis for selected aircraft type pairs in view of upgrading the applied wake categorisation scheme and bringing quick wins.</p>					
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CONTENTS

CONTENTS	4
EXECUTIVE SUMMARY	5
1 RECAT-EU-PWS minima	6
1.1 Background.....	6
1.2 RECAT-EU-PWS solution.....	6
1.3 Static PWS scheme and minima	7
1.3.1 RECAT-EU-PWS matrix with distance-based minima (100+ aircraft type designators)	7
1.3.2 RECAT-EU-PWS matrix with time minima for departure (100+ aircraft type designators)	14
1.4 RECAT '20-CAT' scheme and minima	18
1.4.1 RECAT 20-CAT distance-based minima	19
1.4.2 RECAT 20-CAT Time-based minima for departures	19
1.5 RECAT-EU-PWS/20-CAT Aircraft assignment list	20
1.6 RECAT-EU-PWS 'Maintenance'	20
1.7 Applicability of RECAT-EU-PWS minima	20
1.8 How RECAT-EU-PWS can be operated?.....	21
1.8.1 "Pair-Wise application" for Approach and/or Departure.....	21
1.8.2 Customised N-category scheme.....	22
1.8.3 'Hybrid' ICAO-RECAT EU(-PWS).....	23
1.9 RECAT-EU-PWS safety case and key principles.....	24
2 Delivering runway throughput benefits with RECAT-EU-PWS ..	25
3 RECAT-EU-PWS deployment considerations	26
Appendix A - List of Aircraft Types with PWS minima.....	27
Appendix B - EUROCONTROL RECAT-EU-PWS Safety Case documentation	30
Appendix C – Aircraft type assignment logic into RECAT-EU-PWS scheme	31
ABBREVIATIONS	32

EXECUTIVE SUMMARY

This document, developed along the SESAR 2020 Wave 2 Very Large Demonstration VLD3-W2 “SORT” project, presents the Optimised Wake Turbulence Categorisation and Pair-Wise Separation (PWS) Minima for Approach and Departure, called RECAT-EU-PWS scheme.

The runway throughput in peak period is directly linked with the applicable minimum longitudinal separation between successive traffic on final approach or on departure.

Following **RECAT-EU as an initial step** of re-categorisation of ICAO legacy wake turbulence categories into a 6-category scheme, an additional optimisation step consists in the determination of static wake turbulence separation minima based on a **“Pair-Wise” regime, i.e., between pairs of aircraft types**.

The PWS minima are determined by similar principles as used for the RECAT-EU methodology and safety metrics, with refinements to provide adequate assurance for a pair-wise level of analysis and wake risk.

The PWS minima have been determined for **a list of 100+ aircraft types** (defined by an ICAO type designator), most frequent at major European airports and for which data are available to characterize the wake generation and wake encounter resistance with sufficient safety assurance. To further complete for all other less frequent types, a **RECAT-EU 20 CAT scheme** has been established, by subdivision of the RECAT-EU categories, and where the aircraft are assigned to one of the 20 categories, based on their MTOM (Maximum Take Off Mass), span and wing aspect ratio.

There are three ways to operate the RECAT-EU PWS solutions:

- **Pair-Wise application**, which requires automation support with an ATC separation delivery tool, which could also enable time-based separation and optimum runway delivery (TBS-ORD);
- a **customized N-category scheme**, defined to be an optimum for a given airport traffic mix;
- a procedural wake minima enhancement for a **limited number of specific pairs** of aircraft types (or group of pairs)

In terms of benefits, the reduction of wake turbulence separation minima from ICAO legacy wake turbulence categories to the RECAT-EU-PWS minima can increase the runway throughput during peak periods by more than 10%, depending on local airport traffic mix of aircraft types.

Also, at equivalent throughput, the RECAT-EU-PWS separation reduction

- ✓ supports a reduction of the overall flight time for an approach or departure sequence of traffic, which therefore benefits to the whole traffic sequence;
- ✓ offers more flexibility for the Air Traffic Controllers to manage the traffic; and
- ✓ enables more rapid recovery from adverse conditions, helping to reduce the local airport delay and eventually the ATFM delay propagated at network level.

1 RECAT-EU-PWS minima

1.1 Background

As part of SESAR 2020 Industrial Research project PJ02 'AART' (Airport Airside & Runway Throughput), EUROCONTROL led the development of static pair-wise wake turbulence separation for Arrivals and Departures, identified as two SESAR solutions:

[PJ02.01.04 Wake turbulence separation for Arrivals based on static aircraft characteristics \('S-PWS-A'\)](#)

[PJ02.01.06 Wake turbulence separation for Departure based on static aircraft characteristics \(S-PWS-D'\)](#)

Since resulting from optimisation from RECAT-EU, these solutions are also commonly named RECAT-EU-PWS scheme.

This development has been supported by UK NATS, providing an operational expertise review and London Heathrow operational data, in support of the analysis for separation design of some aircraft types.

The S-PWS-A solution is also addressed in the SESAR 2020 Wave 2 Very Large Demonstration VLD3 'SORT' (Safely Optimised Runway Throughput) project, where a demonstration exercise will take place in the London Heathrow airport environment, and following operational deployment expected by 2023.

1.2 RECAT-EU-PWS solution

The RECAT-EU-PWS scheme, establishing optimised longitudinal wake turbulence separation minima for Approach and Departure, is composed of the following:

- a) [For a list of 100+ aircraft type,](#)
"RECAT-EU-PWS matrix" where pair-wise separation minima are specified for a list of 100+ aircraft types (identified by the ICAO type designator), frequent in the traffic at major European airports and covering more than 95% of the traffic.
- b) [For all other aircraft types not in the 100+ / PWS list:](#)
"RECAT-EU-20-CAT" separation matrix specified between 20 Wake Turbulence Categories of aircraft types, consisting in a further optimisation / sub-division of RECAT-EU 6-CAT categories (but not to a pair-wise level).
- c) An [aircraft type assignment list](#) into the RECAT-EU-PWS and RECAT-EU 20-CAT matrices containing all ICAO type designators (2000+)

The PWS and 20-CAT separation matrices are detailed hereafter. The aircraft type assignment list is available separately (MS Excel file), and like for RECAT-EU, will be published on EUROCONTROL and EASA websites following the regulatory approval process.

RECAT-EU-PWS Wake Turbulence Separation Scheme

1.3 Static PWS scheme and minima

1.3.1 RECAT-EU-PWS matrix with distance-based minima (100+ aircraft type designators)

The RECAT-EU PWS minima matrix, presented in [Figure 1](#), covers 103 frequent aircraft types, with wake turbulence distance-based minima applicable on Approach and Departure under ATS surveillance service. The list of aircraft types, for which PWS minima are specified, is provided in Appendix A.

*It must be noted that these **wake turbulence separation minima** have been specified down to 2NM minimum, this in view of possible reduction of minimum surveillance separation (MSS) as developed under SESAR2020 (reference solution: PJ.02-03 'Minimum-Pair Separations based on Required Surveillance Performance'. Note that *some of these wake minima, as specified here (the darker the colour, the larger separation), may become smaller than other local prevailing separation or spacing constraints, such as surveillance minima or runway occupancy time, which in this case prevail and remain applicable on top of the wake turbulence separation minima.**

	A388	B748	B77L	B77W	A359	A35K	B744	A346	A345	B773	B772	A343	A332	A333	A342	B789	B788	MD11	B764	B762	B763	A306	A30B	A310	B752	B753
A388	2.5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5
B748		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
B77L		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
B77W		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
A359		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
A35K		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
B744		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
A346		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
A345		2	2	2	2.5	2.5	2	2.5	2.5	2.5	2.5	3	3	3	3	2.5	2.5	2.5	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5
B773		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
B772		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
A343		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
A332		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
A333		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
A342		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
B789		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
B788		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3.5	3.5	3.5	3.5	3.5
MD11		2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2	2	2	2.5	3	3	3	3	3	3	3
B764		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2.5
B762		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2.5
B763		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	2.5
A306		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5
A30B		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5
A310		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5
B752		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
B753		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

RECAT-EU-PWS Wake Turbulence Separation Scheme

	B38M	A21N	A20N	BCS3	BCS1	B739	B738	B737	B736	A321	A320	A318	A319	MD83	MD82	A148	B734	B733	B735	E195	E190	GL5T	GLEX	GLF5	B712	F100	F70	B463	RJ1H	RJ85	E170	CRJ7	CRJ9	GLF4
A388	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
B748	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B77L	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B77W	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
A359	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
A35K	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B744	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
A346	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
A345	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B773	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
B772	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
A343	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
A332	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
A333	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
A342	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
B789	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
B788	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5	4	4	4	4	4	4.5	4	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4
MD11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
B764	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	3	2.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3
B762	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	3	2.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3
B763	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	2.5	3	3	2.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3
A306	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3.5	3.5	3.5	3.5	3
A308	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3.5	3.5	3.5	3.5	3
A310	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.5	3	3	3	3	3	3	3	3	3	3	3	3.5	3.5	3.5	3.5	3.5	3.5	3
B752	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	2	2	2	2	2.5	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5
B753	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2.5	2	2	2	2	2	2.5	2	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	2.5

RECAT-EU-PWS Wake Turbulence Separation Scheme

	F27	F50	DH8D	AT75	AT72	FA7X	AT43	AT45	CRJ2	J328	E145	E135	CL30	F2TH	F900	FA50	CL60	GALX
A388	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
B748	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
B77L	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
B77W	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
A359	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
A35K	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
B744	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
A346	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
A345	4.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
B773	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
B772	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
A343	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
A332	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
A333	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
A342	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
B789	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
B788	4.5	5	5	5	5	4.5	5	5	5	5	5	5	5	5	5	5	5	5
MD11	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
B764	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	3.5	4	4	4	4	4	4
B762	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	3.5	4	4	4	4	4	4
B763	3	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	3.5	4	4	4	4	4	4
A306	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4	4	4	4	4	4	4	4	4	4
A30B	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4	4	4	4	4	4	4	4	4	4
A310	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4	4	4	4	4	4	4	4	4	4
B752	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3	3	3	3	3	3.5
B753	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3	3	3	3	3	3.5

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
A388	7	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8
B748	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
B77L	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
B77W	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
A359	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
A35K	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
B744	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
A346	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
A345	5.5	6	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6	5.5	6.5	7	6.5	6.5	7	6.5	6.5	7	7	7	7
B773	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
B772	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
A343	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
A332	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
A333	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
A342	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
B789	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
B788	5.5	5.5	5.5	5.5	6	6	6	5.5	6	6	6	5.5	6.5	5.5	7	7	7	7	7	6.5	7	7	7	7	7
MD11	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6
B764	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	5	5	5	5	5	5	5	5.5	5.5	5.5	5.5
B762	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	5	5	5	5	5	5	5	5.5	5.5	5.5	5.5
B763	4	4	4	4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4	4.5	4.5	5	5	5	5	5	5	5	5.5	5.5	5.5	5.5
A306	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	4.5	5	4.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6
A30B	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	4.5	5	4.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6
A310	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	5	5	5	4.5	5	4.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6
B752	3	3	3	3	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	4	3.5	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
B753	3	3	3	3	3.5	3.5	3.5	3.5	3.5	3.5	4	3.5	4	3.5	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5

RECAT-EU-PWS Wake Turbulence Separation Scheme

	A148	B734	B733	B735	E195	E190	GLST	GLEX	GLF5	B712	F100	F70	B463	RJ1H	RJ85	E170	CRJ7	CRJ9	GLF4	F27	F50	DH8D	AT75	AT72	FA7X	AT43	AT45	CRJ2	J328	E145	E135	CL30	F2TH	F900	FA50	CL60	GALX
B38M														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A21N														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A20N														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
BCS3														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
BCS1														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
B739														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
B738														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
B737														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
B736														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A321														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A320														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A318														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
A319														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
MD83														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
MD82														2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
B38M	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A21N	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A20N	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
BCS3	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
BCS1	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
B739	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
B738	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
B737	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
B736	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A321	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A320	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A318	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A319	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
MD83	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
MD82	3	3	3	3	3	3	3	3	3.5	3	3.5	3	3.5	3	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5
A148							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B734							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B733							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B735							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E195							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E190							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
GL5T							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
GLEX							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
GLF5							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B712							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F100							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F70							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B463							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
RJ1H							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
RJ85							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E170							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
CRJ7							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
CRJ9							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
GLF4							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F27							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F50							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
DH8D							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
AT75							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
AT72							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
FA7X							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
AT43							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
AT45							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
CRJ2							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
J328							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E145							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E135							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
CL30							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F2TH							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
F900							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
FA50							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
CL60							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
GALX							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
SF34							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
D328							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
E120							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
C680							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
C56X							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
H25C							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
C25C							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
LJ45							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
LJ40							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
H25B							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
C560							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
LJ60							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
BE40							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
LJ35							2.5		2.5	2.5	2.5	2.5	2.5	2.5	3	3	2.5	2.5	3	3	3	3	3	3	3
B350							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C25B							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PC12							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C550							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C25A							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C501							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C525							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C510							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
P46T							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PA34							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
C10T							2.5		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Figure 1: RECAT-EU-PWS 103x103 matrix with distance-based Wake turbulence separation minima for approach and departure

The RECAT-EU-PWS matrix is provided as Appendix H to the EUROCONTROL RECAT-EU-PWS Safety Case, under the form of an MS Excel file.

RECAT-EU-PWS Wake Turbulence Separation Scheme

1.3.2 RECAT-EU-PWS matrix with time minima for departure (100+ aircraft type designators)

The RECAT-EU-PWS time-based minima matrix, presented in [Figure 2](#), covers 103 frequent aircraft types, with wake turbulence time-based minima applicable on Departure by Tower ATS service.

	A388	B748	B77L	B77W	A359	A35K	B744	A346	A345	B773	B772	A343	A332	A333	A342	B789	B788	MD11	B764	B762	B763	A306	A30B	A310	B752	B753	B38M	A21N	A20N	BC53	BC51	B739	B738	B737	B736	A321	A320	A318	A319	MD83	MD82		
A388		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	120	120	120	120	120	120	120	120	120	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	
B748																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
B77L																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
B77W																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A359																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A35K																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
B744																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A346																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
A345																										60	60	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
B773																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
B772																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
A343																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
A332																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
A333																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
A342																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
B789																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
B788																										60	60	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
MD11																										60	60	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
B764																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
B762																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
B763																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
A306																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
A30B																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
A310																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
B752																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
B753																										60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60

	A148	B734	B733	B735	E195	E190	GL5T	GLEK	GLF5	B712	F100	F70	B463	RJ1H	RJ85	E170	CRJ7	CRJ9	GLF4	F27	F50	DH8D	AT75	AT72	FA7X	AT43	AT45	CRJ2	J328	E145	E135	CL30	F2TH	F900	FA50	CL60	GALX	
A388	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160
B748	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B77L	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B77W	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
A359	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
A35K	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B744	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
A346	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
A345	110	100	100	100	100	100	110	110	100	110	110	110	110	110	110	110	110	110	110	110	110	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B773	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120
B772	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
A343	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
A332	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
A333	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
A342	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
B789	110	100	100	100	100	100	110	100	100	100	100	100	110	110	110	110	110	110	100	110	120	120	120	120	110	120	120	120	120	120	120	120	120	120	120	120	120	120
B788	110	100	100	100	100																																	

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
A388	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
B748	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B77L	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B77W	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A359	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A35K	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B744	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A346	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A345	130	140	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B773	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B772	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A343	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A332	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A333	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
A342	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B789	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
B788	130	130	130	130	140	140	140	130	140	140	140	130	140	130	140	140	140	140	140	140	140	140	140	140	140
MD11	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B764	100	100	100	100	110	110	110	110	110	110	110	100	110	110	120	120	120	120	120	120	120	120	120	120	120
B762	100	100	100	100	110	110	110	110	110	110	110	100	110	110	120	120	120	120	120	120	120	120	120	120	120
B763	100	100	100	100	110	110	110	110	110	110	110	100	110	110	120	120	120	120	120	120	120	120	120	120	120
A306	110	110	110	110	110	110	120	110	120	120	120	110	120	110	120	120	120	120	120	120	120	120	120	120	120
A30B	110	110	110	110	110	110	120	110	120	120	120	110	120	110	120	120	120	120	120	120	120	120	120	120	120
A310	110	110	110	110	110	110	120	110	120	120	120	110	120	110	120	120	120	120	120	120	120	120	120	120	120
B752	70	70	70	70	90	90	90	90	90	90	100	90	100	90	120	120	120	120	120	120	120	120	120	120	120
B753	70	70	70	70	90	90	90	90	90	90	100	90	100	90	120	120	120	120	120	120	120	120	120	120	120

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
B38M	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A21N	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A20N	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
BCS3	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
BCS1	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
B739	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
B738	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
B737	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
B736	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A321	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A320	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A318	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A319	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
MD83	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
MD82	70	70	70	70	70	70	70	70	90	70	90	70	90	70	120	120	120	120	120	120	120	120	120	120	120
A148															100	100	100	100	100	100	100	100	100	100	100
B734															100	100	100	100	100	100	100	100	100	100	100
B733															100	100	100	100	100	100	100	100	100	100	100
B735															100	100	100	100	100	100	100	100	100	100	100
E195															100	100	100	100	100	100	100	100	100	100	100
E190															100	100	100	100	100	100	100	100	100	100	100
GL5T															100	100	100	100	100	100	100	100	100	100	100
GLEX															100	100	100	100	100	100	100	100	100	100	100
GLF5															100	100	100	100	100	100	100	100	100	100	100
B712															100	100	100	100	100	100	100	100	100	100	100
F100															100	100	100	100	100	100	100	100	100	100	100
F70															100	100	100	100	100	100	100	100	100	100	100
B463															100	100	100	100	100	100	100	100	100	100	100
RJ1H															100	100	100	100	100	100	100	100	100	100	100
RJ85															100	100	100	100	100	100	100	100	100	100	100
E170															100	100	100	100	100	100	100	100	100	100	100
CRJ7															100	100	100	100	100	100	100	100	100	100	100
CRJ9															100	100	100	100	100	100	100	100	100	100	100
GLF4															100	100	100	100	100	100	100	100	100	100	100
F27															100	100	100	100	100	100	100	100	100	100	100
F50															100	100	100	100	100	100	100	100	100	100	100
DH8D															100	100	100	100	100	100	100	100	100	100	100
AT75															100	100	100	100	100	100	100	100	100	100	100
AT72															100	100	100	100	100	100	100	100	100	100	100
FA7X															100	100	100	100	100	100	100	100	100	100	100
AT43															100	100	100	100	100	100	100	100	100	100	100
AT45															100	100	100	100	100	100	100	100	100	100	100
CRJ2															100	100	100	100	100	100	100	100	100	100	100
J328															100	100	100	100	100	100	100	100	100	100	100
E145															100	100	100	100	100	100	100	100	100	100	100
E135															100	100	100	100	100	100	100	100	100	100	100
CL30															100	100	100	100	100	100	100	100	100	100	100
F2TH															100	100	100	100	100	100	100	100	100	100	100
F900															100	100	100	100	100	100	100	100	100	100	100
FA50															100	100	100	100	100	100	100	100	100	100	100
CL60															100	100	100	100	100	100	100	100	100	100	100
GALX															100	100	100	100	100	100	100	100	100	100	100

RECAT-EU-PWS Wake Turbulence Separation Scheme

	SF34	D328	E120	C680	C56X	H25C	C25C	LJ45	LJ40	H25B	C560	LJ60	BE40	LJ35	B350	C25B	PC12	C550	C25A	C501	C525	C510	P46T	PA34	C10T
SF34															80	80	80	80	80	80	80	80	80	80	80
D328															80	80	80	80	80	80	80	80	80	80	80
E120															80	80	80	80	80	80	80	80	80	80	80
C680															80	80	80	80	80	80	80	80	80	80	80
C56X															80	80	80	80	80	80	80	80	80	80	80
H25C															80	80	80	80	80	80	80	80	80	80	80
C25C															80	80	80	80	80	80	80	80	80	80	80
LJ45															80	80	80	80	80	80	80	80	80	80	80
LJ40															80	80	80	80	80	80	80	80	80	80	80
H25B															80	80	80	80	80	80	80	80	80	80	80
C560															80	80	80	80	80	80	80	80	80	80	80
LJ60															80	80	80	80	80	80	80	80	80	80	80
BE40															80	80	80	80	80	80	80	80	80	80	80
LJ35															80	80	80	80	80	80	80	80	80	80	80
B350																									
C25B																									
PC12																									
C550																									
C25A																									
C501																									
C525																									
C510																									
P46T																									
PA34																									
C10T																									

Figure 2: RECAT-EU-PWS 103x103 matrix with time-based Wake turbulence separation minima for departures

The RECAT-EU-PWS time-based matrix for departure is provided as Appendix I to the EUROCONTROL RECAT-EU-PWS Safety Case, under the form of an MS Excel file.

1.4 RECAT '20-CAT' scheme and minima

Based on the PWS matrix and list of aircraft types, a scheme with 20 wake turbulence categories is covering all aircraft types including those not in the 'PWS' list.

A 14 categories scheme is built to assign most of the aircraft types (including some not in the PWS list) on the basis of design similarities with aircraft types from the PWS list, defining a **14-CAT scheme**.

This is further completed by the RECAT-EU 6 categories for the remaining rarer and more specific aircraft types, leading to an **overall 20-CAT scheme**.

Table 2 contains a selection of aircraft types which are among the 103 types in the PWS list, and used as reference to establish the 14 categories.

Cat Name	A1	B1	B2	C1	C2	C3	C4	D1	E1	E2	E3	F1	F2	F3
Ac type in 96 list	A388	B77L B77W A351 A359 A358 B744 A346 A345	B773 B772 A343 A332 A333 A342 B788	MD11	B764 B762 B763	A306 A30B A310	B752 B753	B739 B738 B737 B736 B735 A321 A320 A318 A319 MD83 MD82	A148 B734 B733 B735 E190 GL5T GLEX GLF5 B712 F100 F70 B463 RJ1H RJ85 E170 CRJ7 CRJ9 GLF4	F27 F50 DH8D AT75 AT72 FA7X AT43 AT45	CRJ2 J328 E145 E135 CL30 F2TH F900 FA50 CL60 GALX	SF34 D328 E120 C680	C56X H25C C25C LJ45 LJ40 H25B C560 LJ60 BE40 LJ35	B350 C25B PC12 C550 C25A C501 C525 C510 P46T PA34 C10T

Table 1 Example of assignment into the 14-Category scheme of the RECAT-EU 20CAT, with correspondence to aircraft types from the PWS list

Table 2 contains a selection of aircraft types not in the PWS list, and assigned to the 14-CAT, for which separation minima are still further optimised compared to RECAT-EU.

14-Category designators	A1	B1	B2	C1	C2	C3	C4	D1	E1	E2	E3	F1	F2	F3
Selection of aircraft types assigned in 14-CAT (not currently assigned in PWS list)		B778 B779 ...	A338 A339 B78X ...	DC10 ...	IL76 ...	A3ST ...	(no other type than B757 being in the PWS list)	A19N B37M B39M B3XM MD90 T154 ...	AN72 CRJX E75S E75L FA8X GLF6 MRJ7 MRJ9 SU95 ...	AN32 AT46 AT73 AT76 DH8C FA6X ...	C750 CRJ1 E35L E45X G280 LJ85 ...	C68A DHC4 ...	B190 C650 FA20 JS41 LJ55 LJ75 PC24 ...	All types from ICAO Light WTC, except [C10T, C25A, C25B, C501, C510, C525, C550, P46T, PA34, PC12] which are in the PWS list

Table 2 Example of assignment into the 14-Category scheme of the RECAT-EU 20CAT, with correspondence to aircraft types from the PWS list

This assignment is based on criteria comprising mass, wingspan and wing aspect ratio, and can be resulting from a specific analysis, such as for the A330Neo (A338, A339) or Boeing 777X (B778, B779).

For aircraft types that do not fall into one of the 14 additional categories, RECAT-EU 6-CAT category is maintained, enabling full coverage of the whole aircraft type fleet.

The assignment of all ICAO type designators into this 20-CAT is available in a dedicated list (Appendix G to the EUROCONTROL RECAT-EU-PWS Safety Case, under the form of an MS Excel file).

RECAT-EU-PWS Wake Turbulence Separation Scheme

1.4.1 RECAT 20-CAT distance-based minima

The distance-based separation minima for the 20-CAT wake scheme are provided in [Figure 3](#). The matrix provides wake turbulence distance-based minima applicable on Approach and Departure under ATS surveillance service.

	A1	A	B1	B2	B	C1	C2	C3	C4	C	D1	D	E1	E2	E3	E	F1	F2	F3	F
A	3.0	3.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	6.0	8.0	8.0	8.0	8.0
A1	2.5	3.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	6.0	7.0	7.0	8.0	8.0
B	2.5	2.5	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.0	7.0	7.0	7.0	7.0
B1		2.5	2.5	3.0	3.0	3.0	3.5	3.5	3.5	4.0	4.0	4.0	4.5	5.0	5.0	5.0	6.0	6.5	7.0	7.0
B2		2.0	2.0	2.5	2.5	2.5	3.0	3.5	3.5	3.5	3.5	4.0	4.5	5.0	5.0	5.0	5.5	6.5	7.0	7.0
C		2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	5.5	6.0	6.0	6.0
C1		2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	5.0	5.0	6.0	6.0
C3		2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	3.0	3.5	4.0	4.0	4.0	4.5	5.0	6.0	6.0
C2		2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	2.5	3.0	3.5	3.5	4.0	4.0	4.0	4.5	6.0	6.0
C4		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	3.0	3.5	3.5	3.5	4.0	6.0	6.0
D												2.5	2.5	2.5	2.5	2.5	3.5	4.0	5.0	5.0
D1												2.5	2.5	2.5	2.5	2.5	3.0	3.5	5.0	5.0
E												2.5	2.5	2.5	2.5	2.5	3.0	3.5	4.0	4.0
E1																		2.5	4.0	4.0
E2																		2.5	4.0	4.0
E3																		2.5	4.0	4.0
F																		2.5	3.0	3.0
F1																		2.5	3.0	3.0
F2																		2.5	3.0	3.0
F3																		2.5	2.5	2.5

Figure 3: 20-CAT Distance-based wake turbulence separation minima for approach and departures

1.4.2 RECAT 20-CAT Time-based minima for departures

The time-based separation minima for the 20-CAT wake scheme are provided in [Figure 4](#). The matrix provides wake turbulence time-based minima applicable on Departure by Tower ATS service.

	A1	A	B1	B2	B	C1	C2	C3	C4	C	D1	D	E1	E2	E3	E	F1	F2	F3	F
A			100.0	100.0	100.0	120.0	120.0	120.0	120.0	120.0	140.0	140.0	160.0	160.0	160.0	160.0	180.0	180.0	180.0	180.0
A1			100.0	100.0	100.0	120.0	120.0	120.0	120.0	120.0	140.0	140.0	160.0	160.0	160.0	160.0	180.0	180.0	180.0	180.0
B									60.0	60.0	100.0	100.0	120.0	120.0	120.0	120.0	140.0	140.0	140.0	140.0
B1									60.0	60.0	100.0	100.0	110.0	120.0	120.0	120.0	140.0	140.0	140.0	140.0
B2									60.0	60.0	90.0	100.0	110.0	120.0	120.0	120.0	130.0	140.0	140.0	140.0
C									60.0	60.0	80.0	80.0	100.0	100.0	100.0	100.0	120.0	120.0	120.0	120.0
C1									60.0	60.0	80.0	80.0	100.0	100.0	100.0	100.0	120.0	120.0	120.0	120.0
C3									60.0	60.0	60.0	70.0	90.0	100.0	100.0	100.0	110.0	120.0	120.0	120.0
C2									60.0	60.0	60.0	70.0	90.0	90.0	100.0	100.0	100.0	110.0	120.0	120.0
C4									60.0	60.0	60.0	60.0	60.0	70.0	90.0	90.0	90.0	100.0	120.0	120.0
D																	90.0	100.0	120.0	120.0
D1																	70.0	90.0	120.0	120.0
E																			100.0	100.0
E1																			100.0	100.0
E2																			100.0	100.0
E3																			100.0	100.0
F																			80.0	80.0
F1																			80.0	80.0
F2																			80.0	80.0
F3																				

Figure 4: RECAT 20-CAT Time-based wake turbulence separation minima for departures

1.5 RECAT-EU-PWS/20-CAT Aircraft assignment list

A list of aircraft type assignment with all ICAO type designators assigned into the RECAT-EU 20-CAT, and identifying the types of the PWS list, is developed and will be maintained for including new type designator identified in ICAO Doc 8643.

The RECAT-EU-PWS/20CAT aircraft assignment list is provided as Appendix G to the EUROCONTROL RECAT-EU-PWS Safety Case, under the form of an MS Excel file.

1.6 RECAT-EU-PWS 'Maintenance'

- PWS matrix

As the traffic mix is evolving over time and some aircraft types will become frequent at major European airports, the PWS matrix will periodically evolve as well to incorporate additional frequent aircraft types based on their data-driven characterisation

- RECAT-EU-PWS aircraft assignment list

Since new aircraft type designators are periodically added over time, the RECAT-EU-PWS aircraft assignment list will periodically evolve as well to incorporate additional aircraft types.

The aircraft type assignment logic is illustrated in Appendix C.

1.7 Applicability of RECAT-EU-PWS minima

The distance-based separation minima are static, being applicable under ATS surveillance service and **conditions (same as for RECAT-EU) defined in regulation EU 2020/469 ATS.TR.220 and ICAO Document 4444 PANS-ATM Section 8.7.3.4.1**, when:

- a) an aircraft is operating directly behind another aircraft at the same altitude or less than 300 m (1 000 ft) below; or
- b) both aircraft are using the same runway, or parallel runways separated by less than 760 m (2 500 ft); or
- c) an aircraft is crossing behind another aircraft, at the same altitude or less than 300 m (1 000 ft) below.

The time-based separation minima are applicable under Tower ATS service and **conditions (same as for RECAT-EU) defined in regulation EU 2020/469 ATS.TR.220 and ICAO Document 4444 PANS-ATM Section 5.8.3 Departing aircraft**, when the aircraft are using:

- a) the same runway;
- b) parallel runways separated by less than 760 m (2 500 ft);
- c) crossing runways if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1 000 ft) below;
- d) parallel runways separated by 760 m (2 500 ft) or more, if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1 000 ft) below.

Like for ICAO Doc 4444 §5.8.3.3, when aircraft take off from an intermediate part of the same runway or an intermediate part of a parallel runway separated by less than 760 m (2 500 ft), an additional minute is applicable to all minima.

1.8 How RECAT-EU-PWS can be operated?

There are three ways to operate the RECAT-EU PWS solutions.

1.8.1 “Pair-Wise application” for Approach and/or Departure

The PWS minima can be applied as such, completed by the 20-category separation matrix for other landplane aircraft ICAO types (or any other category-based separation scheme approved by local regulation authority).

It must be noted that the list of pairwise aircraft types is based on frequent types in the European traffic for which data (in particular approach speed profile) are available for PWS minima determination. Locally the pairwise aircraft types will not all be found at an airport.

For covering all local traffic types, a **local PWS matrix** must be established, from the combination of the PWS matrix, and from the category-based scheme for the remaining other (less frequent) aircraft types.

The pair-wise application requires an ATC separation delivery tool, which can be distance-based or could also enable time-based separation and optimum runway delivery (TBS-ORD), as illustrated in Figure 5.

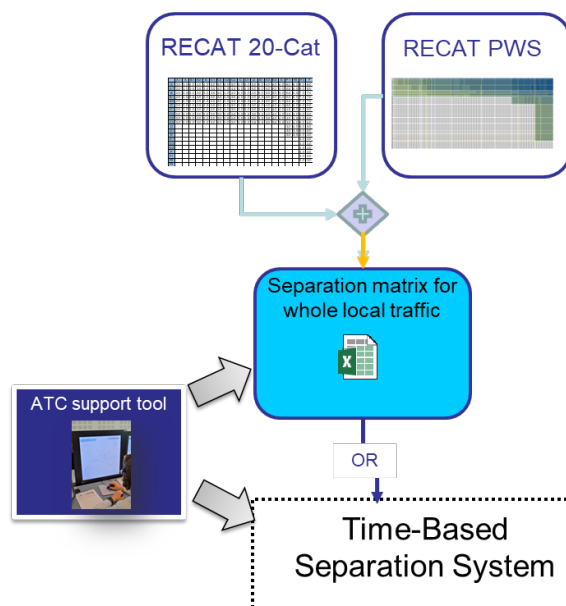


Figure 5: Operations of Pair-wise separation with support of ATC separation delivery tool

1.8.2 Customised N-category scheme

The RECAT-EU-PWS and RECAT-EU 20 CAT solutions can also be used to establish a **customized N-category scheme**, defined to be an optimum for a given traffic mix at an aerodrome, and built using a grouping of:

- categories of the 20-category scheme; or
- categories of the 20-category scheme complemented by another regulated standard (e.g., ICAO).

Such N-category scheme, applicable both on approach and departure, may need an ATC separation support tool, or not, depending on the number of categories and associated complexity of separation combination to be managed by ATC, as illustrated in [Figure 6](#). The customized N-category separation scheme solution can correspond to RECAT-EU 6-CAT grouping (since RECAT-EU 20CAT minima are inclusive of it), but also allows further local optimization considering local traffic mix.

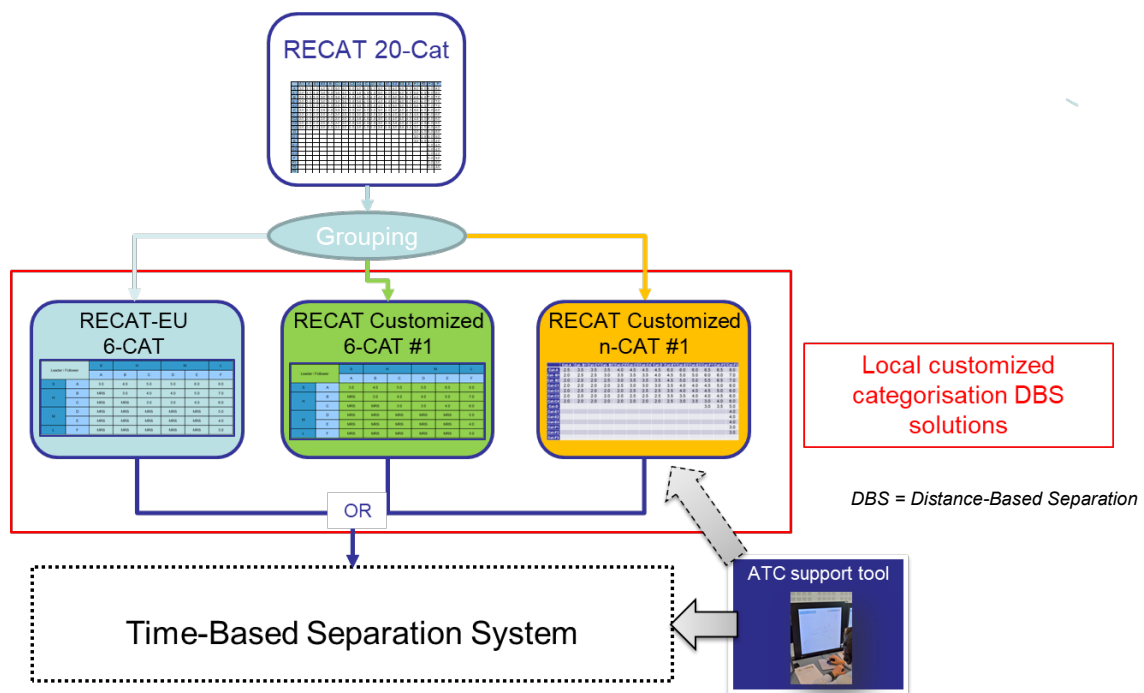


Figure 6: Operations of customised wake categories based on 20-CAT scheme with or without support of ATC separation delivery tool

RECAT-EU-PWS Wake Turbulence Separation Scheme

Example of customised 7-CAT solution

Figure 7 provides an example of customised 7-CAT wake turbulence separation scheme solution which can be of interest to some airports with high percentage of ICAO Medium wake category aircraft types.

	Cat-A1	Cat- B1	Cat-B2	Cat-C1	Cat-C2	Cat-C3	Cat-C4	Cat-D1	Cat-E1	Cat-E2	Cat-E3	Cat-F1	Cat-F2	Cat-F3
Cat-A1	2.5	4.0	4.0	5.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	7.0	7.0	8.0
Cat- B1	2.0	2.5	3.0	3.0	3.5	3.5	3.5	4.0	4.5	5.0	5.0	6.0	6.5	7.0
Cat- B2	2.0	2.0	2.5	2.5	3.0	3.5	3.5	3.5	4.5	5.0	5.0	5.5	6.5	7.0
Cat-C1	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.0	4.0	4.0	4.0	5.0	5.0	6.0
Cat-C3	2.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	3.5	4.0	4.0	4.5	5.0	6.0
Cat-C2	2.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	3.5	3.5	4.0	4.0	4.5	6.0
Cat-C4	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	3.0	3.5	3.5	4.0	6.0
Cat-D1												3.0	3.5	5.0
Cat-E1														4.0
Cat-E2														4.0
Cat-E3														4.0
Cat-F1														3.0
Cat-F2														3.0
Cat-F3														

	S	H	UM	MM Cat-E1	LM Cat-E2/3	SM / UL	LL
S		5.0	5.0	6.0	6.0	7.0	8.0
H		4.0	4.0	4.5	5.0	6.5	7.0
UM						3.5	5.0
MM Cat-E1							4.0
LM Cat-E2/-E3							4.0
SM / UL							3.0
LL							

Figure 7: Example of customised 7-CAT wake turbulence separation scheme derived from 20-CAT scheme

1.8.3 'Hybrid' ICAO-RECAT EU(-PWS)

For airports with specific traffic mix and frequent pairs involving heavy aircraft (e.g., A333-A320, B789-A320, or B789-B738), it is possible to keep operating ICAO legacy with a **wake minima enhancement between a limited number of specific pairs of aircraft types** (or group of pairs, e.g., A320 family following A330 family), for ATC procedural application or with limited system and HMI upgrade.

1.9 RECAT-EU-PWS safety case and key principles

The wake turbulence pair-wise separation (PWS) minima are directly determined from the **wake turbulence pair-wise risk assessment**, with detailed assurance provided in a Safety Case.

The minima are established by **direct comparison** between aircraft type pairs of wake turbulence encounter severity (determined in so-called reasonable worst-case conditions - RWC), and alignment onto levels defined by 'pivot' aircraft type pairs at ICAO separation minima as operated today, considered as acceptable.

Although the PWS design logic is to align most of the pairs to a higher Wake Turbulence (WT) severity exposure, some margins have been introduced by the selection of the reference pairs (named 'pivot' pairs) with corresponding WT severity level. Reference baseline pairs are selected to determine acceptable Roll Moment Coefficient (RMC) values for PWS design by alignment of other pairs to that WT severity level. The reference leader-follower pair could theoretically be a "worst-case" (most exposed) pair in ICAO scheme. However, the selected pairs should provide the assurance that

- the corresponding exposure level has been frequently experienced (aircraft type pair frequent in traffic mix in peak time at busiest European airports),
- that it does not lead to an increase of the risk of WT-induced accident and decreases this risk for the most exposed pairs, and
- it will provide an acceptable evolution in terms of overall risk.

The PWS minima are then determined by aligning the calculated severity level (expressed in RMC) on that of reference pivot aircraft type pairs. Comparing PWS and ICAO minima, the WT risk in RWC is increased for the lowest severity levels, while the highest severity levels are reduced for smaller types, leading to a more aligned distribution.

The determination of time-based static pairwise separation scheme for departures relies on the same methodology used to develop the time-based RECAT-EU departure scheme which has been approved by EASA. This methodology defines the allowed time-based separation reductions/increases for departures compared to ICAO standard, based on the allowed distance-based separation reductions/increases allowed by distance-based static pairwise scheme compared to the ICAO distance-based separation scheme for arrivals. This methodology is based on the underlying assumption that the derived time-based S-PWS for departures do not lead to a wake turbulence encounter (WTE) severity increase greater than what has been justified for the S-PWS minima design for arrivals. In order to further verify this assumption with Pilots in the loop, a flight simulation campaign, named WISA ('Wake Impact Severity Assessment'), was performed.

Detailed safety assurance is presented in the EUROCONTROL Safety Case report on RECAT-EU-PWS minima for Approach and Departure (ref: see Appendix B).

The safety case has been introduced to EASA for review and basis of regulatory endorsement.

2 Delivering runway throughput benefits with RECAT-EU-PWS

As determined by the SESAR PJ02.01.04 solution validation results and performance assessment, RECAT-EU-PWS deployment will result in significant benefits in terms of runway capacity (increased arrival and departure throughput) and operational efficiency, further than RECAT-EU (based on 6 categories).

- Transitioning from legacy separation minima based on ICAO wake turbulence categories to the RECAT-EU-PWS separation minima can bring up to 10% increase in runway throughput during peak periods, depending on individual airport traffic mix.
In addition, it should be noted that the use of a separation delivery tool (e.g., like for Time-Based Separation and Optimum Runway Delivery TBS-ORD) can bring another 5% increase thanks to enhanced separation consistency and predictability.
- At equivalent throughput, RECAT-EU-PWS also allows a reduction of the overall flight time for an approach or departure sequence of traffic, and this is beneficial to the whole traffic sequence. This may offer more flexibility for the Controllers to manage the traffic.
- RECAT-EU-PWS will also enable more rapid recovery from adverse conditions, helping to reduce the overall delay and will also enable improvements in ATFM slot compliance through the flexibility afforded by reduced departure separations

Examples of PWS minima differences from standard ICAO Wake Turbulence Category or RECAT-EU 6-CAT are provided in Figure 8.

Lead/Follower aircraft type pairing	ICAO WTC minima	RECAT-EU minima	PWS minima (distance ARR / DEP)	PWS minima (time on DEP)
A359/B77W – B763	4 NM (nautical miles)	4 NM	3.5 NM	-
A359/B77W – B764	4 NM	4 NM	3 NM	-
A333/B789 - B738 or B38M	5 NM	4 NM	3.5 NM	90 s
A333/B789 - A320 or A20N	5 NM	4 NM	3.5 NM	90 s
A333/B789 – BCS3 or BCS1	5 NM	4 NM	3.5 NM	90 s
A359/B77W/A333/B789 - E195/E190	5 NM	5 NM	4 NM	100 s
A359/B77W/A333/B789 - E175/E170	5 NM	5 NM	4.5 NM	110 s
B764/B763 - A320 or A20N	5 NM	3 NM	2.5 NM	60 s

Figure 8: Example of PWS minima differences from standard ICAO Wake Turbulence Category or RECAT-EU 6-CAT

3 RECAT-EU-PWS deployment considerations

As identified in the EUROCONTROL RECAT-EU-PWS safety case report, the following elements should be considered when deploying RECAT-EU-PWS minima:

- Ensuring traffic spacing **compatibility with runway occupancy time**;
- Ensure **correct aircraft type data filed into flight plans**;
- Ensuring Air Traffic Controllers appropriate training on ATC automation support and separation delivery tool for managing increased complexity;
- Ensuring **Aircraft Operators and Flight Crews awareness** of
 - Locally applicable wake turbulence separation minima based on RECAT-EU-PWS (*),
 - Operations at or close to separation minima is associated to “High-Intensity Runway Operations” (e.g. minimizing runway occupancy time),
 - Possible overall increase in lower severity wake turbulence encounter frequency on approach / departure, and the recommendation for ensuring that cabin crews should be seated before final approach interception;
- Ensuring safety monitoring in operations.

(*) In case of Pair-wise separation application, the combination of possible separation minima is (too) complex to memorize unlike the reference conventional wake separation (e.g., 5NM for a Medium behind Heavy). However, what is of most interest for Flight Crews is the wake separation minima for the aircraft type he/she is flying on, and so the corresponding column from the separation matrix. Also, the separation minima behind Heavy aircraft are grouped by clusters of Heavy aircraft type (in line with the Categories from the 20-CAT scheme), which significantly reduce the number of various minima cases. Examples for few aircraft types are provided in Figure 9

Leader Aircraft type	A320	E190	ATR72
A380	5 NM	6 NM	6 NM
A350/B77W/B744	4 NM	4 NM	5 NM
A330/B777	3.5 NM	4 NM	5 NM
MD11	3 NM	4 NM	4 NM
B767 / A300 / A310	2.5 NM	3 NM	3.5 NM
B757	2 NM	2.5 NM	2.5 NM

Figure 9: Examples of PWS minima for some aircraft types as followers behind various frequent large aircraft types as leader

Appendix A - List of Aircraft Types with PWS minima

The list of aircraft types assigned to the pair-wise (PWS) wake turbulence scheme, with corresponding ICAO and RECAT-EU wake categories, are provided in Table 3.

Manufacturer	Model	ICAO Type Designator	ICAO Wake Turbulence Category	RECAT-EU
ANTONOV	An-148	A148	M	CAT-E
AIRBUS	A320NEO	A20N	M	CAT-D
AIRBUS	A321NEO	A21N	M	CAT-D
AIRBUS	A300B4-600	A306	H	CAT-C
AIRBUS	A300B2-1	A30B	H	CAT-C
AIRBUS	A310	A310	H	CAT-C
AIRBUS	A318	A318	M	CAT-D
AIRBUS	A319	A319	M	CAT-D
AIRBUS	A320	A320	M	CAT-D
AIRBUS	A321	A321	M	CAT-D
AIRBUS	A330-200	A332	H	CAT-B
AIRBUS	A330-300	A333	H	CAT-B
AIRBUS	A340-200	A342	H	CAT-B
AIRBUS	A340-300	A343	H	CAT-B
AIRBUS	A340-500	A345	H	CAT-B
AIRBUS	A340-600	A346	H	CAT-B
AIRBUS	A350-900 XWB	A359	H	CAT-B
AIRBUS	A350-1000 XWB	A35K	H	CAT-B
AIRBUS	A380-800	A388	J	CAT-A
ATR	ATR-42-300	AT43	M	CAT-E
ATR	ATR-42-500	AT45	M	CAT-E
ATR	ATR-72-201	AT72	M	CAT-E
ATR	ATR-72-500	AT75	M	CAT-E
RAYTHEON	300 (B300) Super King Air 350	B350	M	CAT-F
BOEING	737 MAX -8	B38M	M	CAT-D
BRITISH AEROSPACE	BAe-146-300	B463	M	CAT-E
BOEING	717-200	B712	M	CAT-E
BOEING	737-300	B733	M	CAT-E
BOEING	737-400	B734	M	CAT-E
BOEING	737-500	B735	M	CAT-E
BOEING	737-600	B736	M	CAT-D
BOEING	737-700	B737	M	CAT-D
BOEING	737-800B	B738	M	CAT-D
BOEING	737-900	B739	M	CAT-D
BOEING	747-400 (international, winglets)	B744	H	CAT-B
BOEING	747-8	B748	H	CAT-B

RECAT-EU-PWS Wake Turbulence Separation Scheme

BOEING	757-200	B752	M	CAT-C
BOEING	757-300	B753	M	CAT-C
BOEING	767-200	B762	H	CAT-C
BOEING	767-300	B763	H	CAT-C
BOEING	767-400	B764	H	CAT-C
BOEING	777-200ER	B772	H	CAT-B
BOEING	777-300	B773	H	CAT-B
BOEING	777-200LR	B77L	H	CAT-B
BOEING	777-300ER	B77W	H	CAT-B
BOEING	787-8 Dreamliner	B788	H	CAT-B
BOEING	787-9 Dreamliner	B789	H	CAT-B
AIRBUS	A-220-100	BCS1	M	CAT-D
AIRBUS	A-220-300	BCS3	M	CAT-D
BEECH	400 Beechjet	BE40	M	CAT-F
CESSNA	P210 (turbine)	C10T	L	CAT-F
CESSNA	525A Citation CJ2	C25A	L	CAT-F
CESSNA	525B Citation CJ3	C25B	L	CAT-F
CESSNA	525C Citation CJ4	C25C	M	CAT-F
CESSNA	Citation 1SP	C501	L	CAT-F
CESSNA	510 Citation Mustang	C510	L	CAT-F
CESSNA	525 CitationJet	C525	L	CAT-F
CESSNA	Citation 2	C550	L	CAT-F
CESSNA	560 Citation 5	C560	M	CAT-F
CESSNA	560XL Citation Excel	C56X	M	CAT-F
CESSNA	680 Citation Sovereign	C680	M	CAT-F
BOMBARDIER	Challenger 300	CL30	M	CAT-E
CANADAIR	CL-600 Challenger 600	CL60	M	CAT-E
CANADAIR	Regional Jet CRJ-200	CRJ2	M	CAT-E
CANADAIR	Regional Jet CRJ-700	CRJ7	M	CAT-E
CANADAIR	Regional Jet CRJ-900	CRJ9	M	CAT-E
FAIRCHILD DORNIER	328	D328	M	CAT-F
DE HAVILLAND CANADA	DHC-8-400 Dash 8	DH8D	M	CAT-E
EMBRAER	EMB-120 Brasilia	E120	M	CAT-F
EMBRAER	EMB-135	E135	M	CAT-E
EMBRAER	EMB-145	E145	M	CAT-E
EMBRAER	EMB-170	E170	M	CAT-E
EMBRAER	EMB-190	E190	M	CAT-E
EMBRAER	EMB-195	E195	M	CAT-E
FOKKER	100	F100	M	CAT-E
FOKKER	F-27 Friendship	F27	M	CAT-E
DASSAULT	Falcon 2000	F2TH	M	CAT-E
FOKKER	Fokker 50	F50	M	CAT-E
FOKKER	70	F70	M	CAT-E
DASSAULT	Falcon 900	F900	M	CAT-E
DASSAULT	Falcon 50	FA50	M	CAT-E

RECAT-EU-PWS Wake Turbulence Separation Scheme

DASSAULT	Falcon 7X	FA7X	M	CAT-E
IAI	Galaxy	GALX	M	CAT-E
BOMBARDIER	BD-700 Global 5000	GL5T	M	CAT-E
RAYTHEON	Sentinel	GLEX	M	CAT-E
GULFSTREAM AEROSPACE	Gulfstream G400/G450	GLF4	M	CAT-E
GULFSTREAM AEROSPACE	Gulfstream G500/G550	GLF5	M	CAT-E
RAYTHEON	Hawker 800	H25B	M	CAT-F
RAYTHEON	Hawker 1000	H25C	M	CAT-F
RUAG	Dornier 328 JET Envoy	J328	M	CAT-E
LEARJET	35	LJ35	M	CAT-F
LEARJET	40	LJ40	M	CAT-F
LEARJET	45	LJ45	M	CAT-F
LEARJET	60	LJ60	M	CAT-F
MCDONNELL DOUGLAS	MD-11	MD11	H	CAT-C
MCDONNELL DOUGLAS	MD-82	MD82	M	CAT-D
MCDONNELL DOUGLAS	MD-83	MD83	M	CAT-D
PIPER	PA-46-500TP Malibu Meridian	P46T	L	CAT-F
PIPER	PA-34 Seneca	PA34	L	CAT-F
PILATUS	Eagle	PC12	L	CAT-F
BRITISH AEROSPACE	RJ-100	RJ1H	M	CAT-E
BRITISH AEROSPACE	RJ-85	RJ85	M	CAT-E
SAAB-FAIRCHILD	SF-340	SF34	M	CAT-F

Table 3: List of aircraft types assigned to the pair-wise (PWS) wake turbulence scheme, with corresponding ICAO and RECAT-EU wake categories.

Appendix B - EUROCONTROL RECAT-EU-PWS Safety Case documentation

The EUROCONTROL RECAT-EU-PWS safety case documentation is essentially composed of the following:

1. EUROCONTROL RECAT-EU-PWS Safety case report

complemented by

Appendix B – Wake turbulence severity metric (Restricted access under NDA¹)

Appendix C – Wake vortex data (Restricted access under NDA¹)

Appendix D – Aircraft types and arrival traffic Data (Restricted access under NDA¹)

Appendix E – Wake turbulence risk assessment additional results

Appendix F - RECAT-EU Appendix on Wake turbulence risk assessment for CAT-A / A380 (Restricted access under NDA²)

[Appendix G – RECAT-EU-PWS Aircraft assignment list \(MS Excel file\)](#)

[Appendix H – RECAT-EU-PWS Pair-wise distance minima matrix \(MS Excel file\)](#)

[Appendix I – RECAT-EU-PWS Pair-wise time minima matrix \(MS Excel file\)](#)

Like with RECAT-EU, the RECAT-EU-PWS Aircraft assignment list will be maintained and published following the regulatory approval process.

¹ Covered by Non-Disclosure Agreement (NDA) with EUROCONTROL as containing Stakeholders proprietary data

² Covered by Non-Disclosure Agreement (NDA) with AIRBUS as containing proprietary data

Appendix C – Aircraft type assignment logic into RECAT-EU-PWS scheme

The assignment logic of aircraft types into the RECAT-EU-PWS scheme is illustrated in Figure 10.

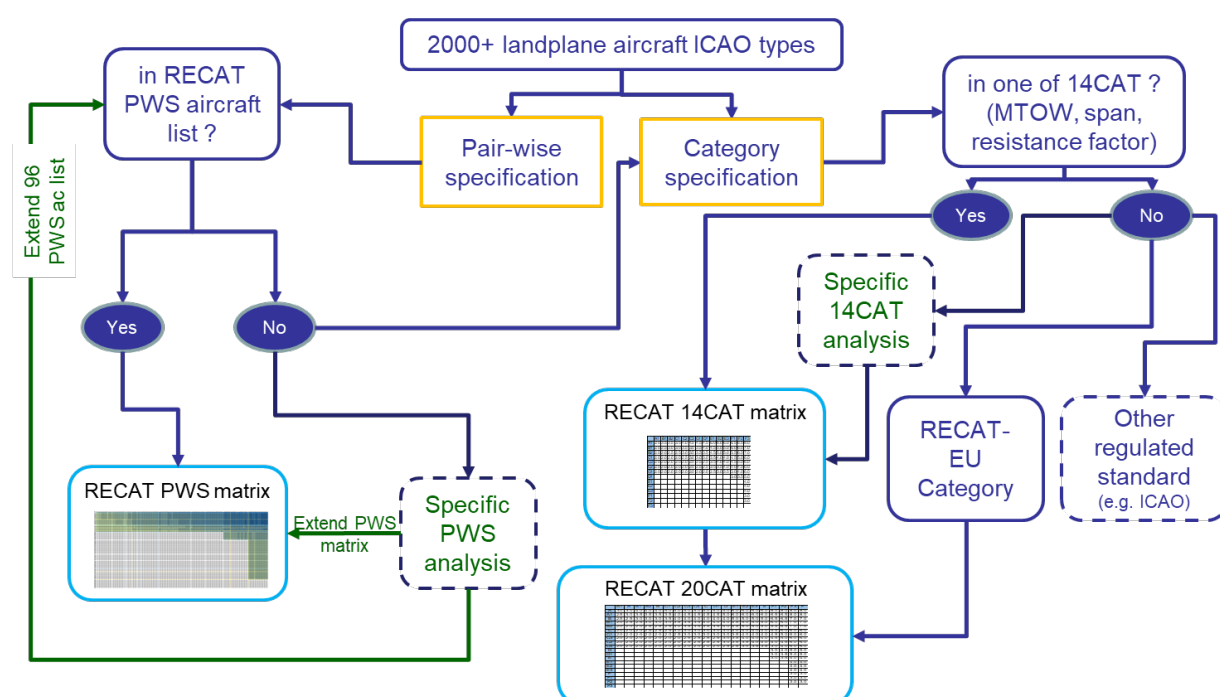


Figure 10: Aircraft type assignment logic into the RECAT-EU-PWS scheme

ABBREVIATIONS

ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Flow Management
ATS	Air Traffic Services
CAT	Category
EASA	European Aviation Safety Agency
EUROCONTROL	European Organisation for the Safety of Air Navigation
ICAO	International Civil Aviation Organisation
MRS	Minimum Radar Separation
MSS	Minimum Surveillance Separation
MTOM	Maximum certificated Take-Off Mass
MTOW	Maximum Take-Off Weight
NATS	UK National Air Traffic Services
NDA	Non-Disclosure Agreement
NM	Nautical Mile
NMD	EUROCONTROL Network Management Directorate
ORD	Optimum Runway Delivery
PWS	Pair-Wise Separation
R&D	Research and Development
RECAT	Re-categorisation
RMC	Roll Moment Coefficient
RWC	Reasonable Worst-case Conditions
S-PWS-A	Static Pair-Wise Separation for Approach
S-PWS-D	Static Pair-Wise Separation for Departures
TBS	Time-Based Separation
WT	Wake Turbulence



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