Contextual note – PJ.02-01-03 "Weather-Dependent Reductions of Wake Turbulence Separations for Departures" (V3) Description Form for Deployment Planning

1. Purpose

This contextual note describes solution PJ.02-01-03 "Weather-Dependent Reductions of Wake Turbulence Separations for Departures" with a summary of the results stemming from R&D activities contributing to deliver it. It provides (to both those external and internal to the SESAR programme) an overview of solution PJ.02-01-03 in terms of scope, main operational and performance benefits, relevant system impacts and recommends additional activities that should be conducted during the industrialisation phase or as part of deployment.

This contextual note complements the solution Data Pack comprising the SESAR deliverables required for industrialisation and deployment.

2. Improvements in Air Traffic Management (ATM)

Weather Dependent Separations (WDS) for departures is the conditional reduction or suspension of wake separation minima on path of departures over the straight-out initial departure path, applicable under pre-defined wind conditions, so as, to enable runway throughput increase compared to the applicable standard weather independent wake separation minima. This is on the basis that under the pre-defined wind conditions the wake turbulence generated by the lead aircraft is either wind transported out of the path of the follower aircraft on final approach or has decayed sufficiently to be acceptable to be encountered by the follower aircraft.

The solution covers WDS cross wind concept for departures in segregated mode runway operations. WDS-D provides benefits in terms of efficiency and runway throughput capacity. The efficiency and runway throughput capacity benefit gains will depend on the frequency by which the wind threshold criteria for WDS-D are met. It is important to note that the application of the WDS-D concept will achieved without any negative impact on safety: By bringing the aircraft closer together, the frequency of wake turbulence encounters at lower severity level may increase. However, the pairwise wake turbulence risk will be aligned to what is considered as acceptable today.

The solution targets capacity constrained runways during high intensity runway operations and applies to very large, large and possibly medium airports.

Relevant Operational Environments

OEs	Sub Operating Environments	Definition
Airport (capacity constrained)	Very Large Airport	Airports with more than 250k movements per year
	Large Airport	Airports with more or equal than 150k and less or equal than 250k movements per year
	Medium Airport	Airports with more or equal than 40k and less than 150k movements per year

3. Operational Improvement Steps (OIs) & Enablers

Applicable OI Step:

AO-0304 — Weather-Dependent Reductions of Wake Turbulence Separations for Departures.

Required Enablers:

AERODROME-ATC-19 — Runway Usage Management sub-system capable of processing initial departure path wind conditions information;

REG-0522 — Regulatory provisions for weather-dependent separation minima (WDS).

Optional Enablers:

A/C-47 – On-board management of meteorological data from on-board sensors for sharing and integration by MET service providers;

A/C-48a – Air broadcast of aircraft position/vector (ADS-B OUT) compliant with DO260B;

AERODROME-ATC-60 – Airport ATC system to monitor wake turbulence risk using ground-based LIDAR/Radar;

APP ATC 99 - ATC System to use Real-Time Meteo Information Received From Met Systems;

SWIM-APS-07a - Stakeholder systems consumption of Meteorological Information services for Step 1.

Dependent OI Step (predecessor):

AO-0329 —Optimised Runway Delivery for Departures. This OI step is covered by solution PJ.02-01-02.

Applicable Integrated Roadmap Dataset is DS20.

4. Background and Validation Process

Significant validation and development work was performed on Pairwise separation and TBS throughout SESAR 1 (and before):

- **CREDOS (Cross Wind Reduced Separations for Departure Operations):** The project used measurements of wake vortices taken at St Louis and Frankfurt airports to develop models of wake vortex behaviour. Using Monte Carlo simulation techniques these models have been used to establish safe separations under various crosswind conditions;
- **SESAR1 P06.08.01:** Flexible and Dynamic Use of Wake Turbulence Separations.

In Wave 1, a wake separation scheme based on the crosswind concept has been developed and presented in the methodology described in the SPR-INTEROP/OSED Part II SAR Appendix K. The proposed TB WDS-D wake separation scheme has been employed in one validation exercises in combination with the OSD tool in the context of the proposed TB PWS-D 96x96 & 20-CAT matrices.

Within this solution, a real-time simulation activity was used to validate this concept.

- **RTS5:** Validation of Static Pairwise Separations on Departure (S-PWS-D) and Weather Dependent Separations on Departure (WDS-D) and their integration with a departure Optimised Separation Delivery (OSD) tool on a single runway in segregated mode (London Heathrow).

5. Results and Performance Achievements

The results show that Weather-Dependent Separation for Departures is operationally feasible and acceptable. The tools enabled the ATCOs to provide more granular and reduced weather-dependent wake separations. No substantial departure throughput benefit was realised in the Weather-Dependent scenario compared to the reference scenario, possibly due to controllers trying to achieve a reduced wake separation at the expense of an

optimum departure sequence. The Enhanced OSD tool and WDS-D tool reduces the workload of the ATCO providing them with additional thinking time to perform other tasks.

Wave 1 validation has shown the Weather-Dependent Separation for Departures concept can work with controllers correctly applying reduced wake separations with the use of the Enhanced OSD tool and the WDS-D tool. However, due to the unpredictable nature of meteorological conditions, it is unclear if the concept would provide the potential benefits in runway throughput without assurance that the crosswind will remain from the moment the controller issues a take-off clearance until the follower aircraft is cleared of the initial departure path.

The Enhanced OSD tool was found to reliably and accurately calculate the appropriate wake separation time for most wake pairs. The WDS-D tool was found to reliably and accurate change the Supervisor and Controller GO/NO-GO status based on the crosswind information provided to the tool. There were issues some technical issues in the EFPS system and Countdown Timer, but despite these limitations, the ATCOs said they had a high user confidence in the system, enabling them to perform their tasks in an accurate, timely and efficient manner.

The capacity results showed a 0.2% increase in departure throughput in the WDS-D scenario compared to the reference scenario. This benefit is lower than anticipated, possibly due to controllers trying to achieve a reduced wake separation in the WDS-D scenario at the expense of achieving the most optimal departure sequence. A local benefit assessment prior to implementation should be performed to confirm the expected benefits from WDS-D since they are dependent upon traffic, wind and other variables at each airport e.g. the local departure aircraft lateral navigation performance, time separation evolution over the straight-out initial departure paths, etc.

The safety results show the controllers believe the WDS-D scenario will either have no impact or a positive impact on operational safety compared to current operations.

6. Recommendations and Additional activities

The following recommendations should be taken into consideration during the industrialisation and deployment phases.

- Refine and stabilise the rules used for applying Weather-dependent Separation for Departures reduced separations prior to implementation;

- Further develop the roles and procedures for tool failure scenarios. These procedures need to account for new ATCOs who won’t have experience in applying wake separations without the use of the tool. Training of TWR ATCO's shall emphasize the need for retaining current skills in aircraft WV category acknowledgement and the related spacing;

- Understand to what extent a sequence optimisation tool is necessary to achieve the optimal departure sequence due to more granular wake separations of the Weather-dependent Separation for Departures concept;
- The role and responsibility of the Tower Supervisor in the activation/suspension of WDS-D and the information / tools required to perform his/her work shall be further refined during the industrialization phase;
- To address the potential for human error from the risk of over-reliance on the tool leading to de-skilling of the ATCOs, and the HMI being misleading in the case of SID separation requirements;
- Perform a more refined assessment of the navigational performance of aircraft on the initial departures flight path. In addition, prior to implementation, an analysis to better understand the wind profile and the

rate of change of cross wind on the initial flight departure path is required. This assessment should be conducted in the local environment in which the WDS-D concept is to be implemented

- The Enhanced OSD tool for WDS shall be improved to solve the technical limitations identified during V3 validation activities:
    - Consider the most up to date departure sequence from the EFPS System, including any changes in the order of FDEs in the runway bay of the EFPS system;
    - Include the Countdown timer on the FDE;
    - Display the value of the wake separation time, info on a non-wake pair separation and tool failure in a clearly distinguished manner;
    - The HMI shall highlight that a reduced WDS-D separation is being applied to a particular aircraft.
    - The crosswind value shall be positioned in the centre of/within the regular scanning pattern of the controller.
- An information campaign to airlines is required so that pilots are aware of the reduced separations that may be applied in certain weather / wind conditions and also to ensure that pilots conform to ATCO instructions in a timely manner. Need to ensure pilots are convinced WDS-D is safe and pilots adhere to the instructions given by ATC to ensure WDS separations as applied as if pilots do not conform then the benefits will be reduced.

7. Actors Impacted by the SESAR Solution

The following actors are impacted by PJ.02-01-03:

- Air Traffic Controllers;
- Flight Crew;
- ANSPs;
- Airlines /airspace Users;
- Airport Operators;
- Regulatory Authorities.

8. Impact on Aircraft System

No impact on aircraft system.

9. Impact on Ground Systems

WDS-D requires Enhanced OSD tool support to be integrated in CWP and current TBS system (if present). ORD tool has to be integrated in CWP and current TBS system (if present). The solution is based on existing MET capabilities and information to measure or forecast the crosswind on the final approach path.

The TS/IRS and the SPR-INTEROP/OSED refer to a new MET service (METForWTS service) that has been developed by solution PJ.18-04b. This service has achieved TRL2 in Wave 1 and it may be an option for this solution if further developed and validated in future R&D activities.

10. Regulatory Framework Considerations

It should be stated that it is not possible to specify a generic set of Weather-dependent Separation for Departures rules for EASA approval, however the methodology could be subject to regulation. Investigative analysis has established that local cases (e.g. airport SID design, departure aircraft performance, local changeable wind conditions) will need to be developed and thus Weather-dependent Separation for Departures is not suitable for general approval by EASA. SAR Appendix J describes the methodology of the weather-dependent separation for departures crosswind concept, which forms the basis for an initial proposal for the safety case. This initial proposal would need to be completed for a safety case assessment.

11. Standardisation Framework Considerations

N/A

12. Solution Data pack

Solution PJ.02-01-01 is covered by PJ.02-01 Data Pack that includes the following documents:

- D1.1.01 – PJ02-01 OSED-SPR-INTEROP (Final) Parts I 00.01.02, II, IV and V – 01.02.01 (31/01/2020);
- D1.1.02 – PJ02-01 TS/IRS (Final) – 00.03.04 (06/03/2020)[1];
- D1.1.04 – PJ02-01 VALR (Final) – 00.01.01 (31/01/2020);
- D1.1.05 – PJ02-01 CBA – 00.01.01 (31/01/2020).

[1] The final version of the TS/IRS MS Word document still contains many requirements that are “in progress” status while they have been actually validated. The status of these requirements is properly updated and documented in the SE-DMF that represents the reference for the list of validated requirements.