Contextual note – PJ.02-01-05 “Weather-Dependent Reductions of Wake Turbulence Separations for Final Approach” (V3) Description Form for Deployment Planning

1. Purpose

This contextual note describes SESAR Solution PJ.02-01-05 “Weather-Dependent Reductions of Wake Turbulence Separations for Final Approach” (WDS-A) 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.02-01-05 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)

The solution PJ.02-01-05 “Weather-Dependent Reductions of Wake Turbulence Separations for Final Approach” aims at the optimisation of the ICAO wake turbulence separation by use of weather-dependent separation minima on arrivals (WDS-A), applicable under given wind conditions. This allows conditional reduction or suspension of separation minima for most aircraft pairs, enabling runway throughput increase compared to ICAO scheme, whilst maintaining acceptable levels of safety. 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 demand is high for airport capacity and efficiency at some European airports, and in particular for increased runway throughput. Today's ICAO separations are based on certificated Maximum Take Off Mass (MTOM) and it includes three categories (i.e. Heavy, Medium or Light) allocating all aircraft into one of them. Because the separations are static and applicable in all weather conditions, this leads to over separation in many instances, resulting in a loss of runway throughput.

WDS-A aims at increasing runway throughput increase compared to the applicable standard weather independent wake separation minima. By bringing the aircraft closer together, the frequency of wake turbulence encounters at lower severity level may increase. However, the wake turbulence risk will have to be aligned to what is considered as acceptable today on the basis of proven current operations experience at ICAO minima. In addition the use of the ORD tool (solution PJ.02-01-01) improves the accuracy of separation delivery and reduces the number of unmanaged under-separations.

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-0310 — Weather-Dependent Reductions of Wake Turbulence Separations for Final Approach.

Required enablers:

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

APP ATC 74 - ATC System Support for Reduced, Weather-Dependent Separation Standards in Final Approach;

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;

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

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

Dependent OI Step (predecessor):

AO-0328 —Optimised Runway Delivery on Final Approach (predecessor). This OI step is covered by solution PJ.02-01-01..

Applicable Integrated Roadmap Dataset is DS20.

4. Background and Validation Process

Significant validation and development work was performed during SESAR 1 timeframe (and before):

SESAR1 Validation:

- **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.

Solution PJ.02-01-05 built on this work and developed a methodology for deriving wake separation scheme based on crosswind conditions. The proposed TB WDS-A wake separation scheme has been employed both in real-time and fast-time simulation activities in combination with separation delivery tool:

- **RTS1:** Validation to assess Weather Dependent Separations on the arrival approach (WDS-A) with Optimised Runway Delivery (ORD) tool in a dual approach environment with segregated runway operations;
- **RTS6:** Validation of Wake Turbulence Separations based on Static Aircraft Characteristics on Departure (S-PWS-D) and their integration with a departure Optimised Separation Delivery (OSD) tool plus Weather Dependent Separations on the arrival approach (WDS-A) and their integration with an arrival separation delivery tool;
- **FTS9:** Fast time simulations of ORD, S-PWS and WDS concepts for different airports to support the CBA.

5. Results and Performance Achievements

Results have determined that, both time-based (TB) and distance-based (DB) Weather-Dependent Separation for Arrivals (supported by ORD tool) are operationally feasible and acceptable in complex airport environments. The controllers were able to successfully and safely deliver separations with the tool in the final approach high traffic demands under nominal conditions.

For strong crosswind conditions, the runway throughput capacity per hour improved with WDS-A and the ORD tool compared to reference scenarios ICAO DBS and ICAO TBS from a minimum of 5.1% to a maximum of about 11%.

Controllers reported that thanks to the reduced workload, stress levels, increased situation awareness with WDS and the ORD tool compared to RECAT EU without ORD tool, they were able to allocate spare resources to other tasks, such as detecting possible separation infringement and preventing runway incursions in the tower. In addition, the number of go-arounds is reduced, significantly in specific wind conditions such as a strong crosswind. Safety was not found to be negatively impacted with WDS and the ORD tool.

Controllers reported positively that they found the tool to be useful, reliable, accurate, understandable and that it was found to work robustly in difficult scenarios. All controllers reported that they felt confident when working with the ORD tool under WDS-A. Roles, tasks and procedures when working with WDS and the ORD tool were considered to be clear, consistent and acceptable /usable to all controllers in all positions in the environment and scenarios tested.

Fast time simulation and RTS activity show benefits for this solution when wind criteria are achieved. That means that for WDS-A to be applied the crosswind measured on the ground and over the glide shall be in the order of the 10 knots as a minimum and it shall be persistent for an extended amount of time for allowing several aircraft in the TMA to land with reduced wake separations. The results highlight the importance of having a reliable and accurate weather forecast. Analysis at 2 very large European airports (CDG, BCN) shows that a specific part of the day during which a strong crosswind component is persistent for more than 30 minutes is a rare phenomenon.

The validation results have showed that there is a very limited additional benefit when Weather Dependent Separation (WDS) is deployed in addition to pairwise separations (which already reduces significantly the wake separations); while the former may be used only for a part of the day, the latter can be used during the whole day.

Mode transition from TB WDS to DB RECAT EU was reported to be operationally feasible and acceptable to the ATCOs, although mode transition from Weather-Dependent Separation to RECAT-EU or ICAO during peak traffic period should be avoided.

6. Recommendations and Additional activities

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

- Training would be required for controllers to ensure they are able to apply and maintain the skills to apply non-WDS separation scheme (such as RECAT EU) with no controller tools support;
- To avoid separation infringements prior to interception in a complex dual approach environment e.g. CDG controllers should be trained on the optimal scanning patterns when working with the tool;

- Information campaigns to airlines should be conducted to make sure pilots are aware of the changes in separation scheme under certain weather conditions and to ensure they conform to controller instructions in a timely manner.

- Local seasonal weather analysis is needed before considering the deployment of this solution. Wind now cast / forecast data required for WDS-A operations should be available and suitably reliable, timely and accurate;

- The time separations for the WDS total wind concept need to be more explicitly defined and the consolidation of baseline standards and regulation for both the WDS-A crosswind and total wind concepts need to be finalised within the local safety assessment;

- The CBA in the solution datapack does not cover PJ.02-01-05. Therefore, local conditions and potential combinations with other solutions should be considered before deployment to add the extra benefits while not inducing additional costs.

7. Actors Impacted by the SESAR Solution

The following actors are impacted by AO-0310:

- 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-A requires the ORD tool to be integrated in CWP and current TBS system (if present). The solution is based on existing MET capabilities and information to measure and forecast the wind on the final approach path for planning when WDS-A can be activated.

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

For supporting separation minima reduction, a safety case shall be developed based on the methodology and data mining results.

11. Standardisation Framework Considerations

N/A

12. Solution Data pack

Solution PJ.02-01-05 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);

[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.