Contextual note – PJ.02-01-06 “Wake Turbulence Separations (for Departures) based on Static Aircraft Characteristics” (V3) Description Form for Deployment Planning

Purpose

This contextual note describes SESAR solution PJ.02-01-06 “Wake Turbulence Separations (for Departures) based on Static Aircraft Characteristics)” 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 PJ.02-01-06 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.

Improvements in Air Traffic Management (ATM)

The Static PairWise Separation for Departures (S-PWS-D) concept optimises wake separations between departures on the initial departure path by moving from schemes defined by a small number of wake categories (4 to 7 wake categories) to a scheme defined between aircraft type pairs for the 96 aircraft types frequently at European major airports, together with a scheme defined by a larger number of wake categories (20-CAT (6-CAT + 14-CAT)) for other aircraft type combinations.

S-PWS for departures are applied using the OSD tool; the pairwise separations will be used as input into the OSD tool.

S-PWS-D will provide benefits in terms of efficiency and runway throughput capacity. It is important to note that the application of the S-PWS-D concept will not have 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

Note: The investment on the OSD tool may be only justified only in large and very large airports.

Operational Improvement Steps (OIs) & Enablers

Applicable OI Step:

AO-0323 — Wake Turbulence Separations (for Departures) based on Static Aircraft Characteristics.

Required Enablers:

REG-0523 — Regulatory provisions (AMC) for static pair-wise wake separation minima (S-PWS);

AERODROME-ATC-42b — Airport ATC tool to support static pair-wise wake separation (S-PWS) for departure operations.

Optional Enabler:

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

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.

Background and Validation Process

Significant work was performed by EUROCONTROL and ANSPs (NATS, DSNA, and AUSTROCONTROL) on Pairwise separation and TBS throughout SESAR 1.

- **SESAR1 P06.08.01:** Flexible and Dynamic Use of Wake Turbulence Separations;
- **RECAT-PWS-EU:** Safety Case development.

Solution PJ.02-01-06 builds on this work to further optimise wake turbulence separation rules.

The TB pairwise wake separation scheme (7 -CAT matrix) developed in the RECAT-PWS-EU Safety Case Ed. 1.4 submitted to EASA has been employed in two validation exercises. Additionally the proposed TB 96 x 96 pairwise & 20-CAT matrices have been employed in two validation exercises. Thus TB PWS-D was assessed in five validation exercises with the OSD tool.

Within this solution, real-time simulation activities were used to validate this concept

- **RTS3a:** Validation to assess Static Pairwise Separations on the arrival approach (S-PWS-A) with Optimised Runway Delivery (ORD) tool plus Static Pairwise Separations for departures (S-PWS-D) with Optimised Separation Delivery (OSD) tool under mixed runway operations;
- **RTS4a:** Validation to assess the ORD tool for arrivals plus Static Pairwise Separations on for departures (S-PWS-D) with Optimised Separation Delivery (OSD) tool under mixed runway operations;
- **RTS4b:** Validation to assess Static Pairwise Separations on the arrival approach (S-PWS-A) with Optimised Separation Delivery (OSD) tool plus Static Pairwise Separations for departures (S-PWS-D) with Optimised Separation Delivery (OSD) tool in a dual approach environment with CSPR under segregated and partially segregated runway operations;
- **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);
- **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.

Results and Performance Achievements

Following the validation activities, it can be concluded that PWS-D with OSD for the TBS rules for 7-CAT, for 96x96 Pairwise with 14-CAT and with 20-CAT (14-CAT + 6-CAT) are operationally feasible and acceptable in segregated runway operations.

Controllers provided positive feedback regarding the operational feasibility and acceptability PWS with OSD in mixed mode runway operations. The OSD tool reduces the workload of the ATCO providing them with additional thinking time to perform other tasks. The tool aided the ATCOs in providing more granular and reduced wake separations with reduced workload.

The capacity improvement ranges between 1.3% and 2.0% increase in departure throughput compared to the reference scenario in segregated runway operations.

The system performance data confirmed the increased accuracy and consistency of delivery of departure aircraft both in segregated and partially segregated/mixed mode of runway operations. There were 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 controllers indicated that the tool is indispensable for PWS 96 scheme as it would be impossible for the ATCO to manage a 96X96 matrix without help.

The safety results show the controllers believe the PWS-D scenario with OSD will either have no impact or a positive impact on operational safety compared to current operations. In all PWS-D RTS the tower controllers reported that the change to task role and procedures related to OSD tool in segregated and mixed mode runway operations were clear, consistent, usable and acceptable.

No major concerns relating to the potential for human error were observed and there was found to be no impact on ATCOS situation awareness. The evidence coming from the degraded mode scenario confirmed the tower ATCOs high level of situation awareness. Tower controllers did comment that the OSD tools may increase ‘’head-down’’ time in the tower, which could be a potential issue and which should be investigated in future activities (see recommendations).

Recommendations and Additional activities

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

- The tool support requires further improvements during industrialization:
    - More work is needed to improve the stability and reliability of information presented in the gap management tool to support ATCOs in the application of mixed mode runway operations with PWS and the OSD tool;
    - Highlight when a separation is a WT separation to improve ATCOs situation awareness;

- Information regarding the aircraft sequence and gap/spacing in the arrival traffic flow is required. Although perhaps not essential for operations with one runway entry point, such information would be needed for multiple runway line up entry points i.e. with aircraft departing from more than one runway entry point; aware of the aircraft sequence of both arrivals and departures on all runways they are managing;

- The OSD tool needs to take into consideration the arrivals as well as the departures when a runway is operating in partially segregated / mixed mode runway operations. This information could be provided by electronic flight strips (set up in a mixed mode runway operations configuration), AMAN/DMAN or a bespoke sequence managing tool;

- Other recommendations for solution PJ.02-01-02 (OSD tool /HMI) are also applicable for solution PJ.02-01-06 e.g. further adaptations to the OSD tool are required for partially segregated / mixed mode runway operations.

- To mitigate any negative impact of a degraded mode scenario in which the wrong aircraft type is in flight plan system it is recommended to include the aircraft type as a ground report on first contact;
- To consider a safety net such as protection and/ or warning that the runway is engaged due to an imminent arrival and no departures or crossing are allowed should also be implemented for partially segregated / mixed mode runway operations;
- Training of TWR ATCO's shall emphasize the need for retaining current skills in aircraft WV category acknowledgement and the related spacing, as well as ensuring new recruits are also trained. It shall 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. specific refresher training on maintaining the controllers current skills, working without a support tool would be required;

- An information campaign to airlines is required so that pilots are aware of the changes in separations that may be applied under PWS-D and also to ensure that pilots conform to ATCO instructions in a timely manner. Need to ensure pilots are convinced PWS-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.

- Local environment characteristics where the solution will be deployed need to be taken into consideration when assessing if the solution can be applied safety and accurately without the OSD tool.

- A local benefits assessment prior to implementation should be performed to confirm the expected benefits from PWS-D as results are dependent upon traffic, wind and other variables at each airport.

- Refine guidance, safety case and material supporting regulation of the Static pairwise separation matrix for departures. Develop (i.e. regulation and associated safety cases) a refined methodology for separation minima based on more categories or different categories for more adequacy to local airport environment depending on the traffic mix and the inclusion of new aircraft types in pairwise matrixes. Support the safety evidences for the regulatory approval, the refinement for further benefits increase and the consolidation allowing to facilitate deployment that correspond to optional regulatory enablers

Actors Impacted by the SESAR Solution

The following actors are impacted by solution PJ.02-01-06:

- Air Traffic Controllers;

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

Impact on Aircraft System

No impact on aircraft system.

Impact on Ground Systems

PWS-D requires OSD tool support 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 wind 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.

Regulatory Framework Considerations

The Time-Based PWS-D 7 category scheme was used in exercises, for which a regulatory change as per the RECAT-PWS-EU Safety Case Ed. 1.4 has been proposed to EASA. The TB PWS-D 7 category scheme is expected to become an EASA AMC to Req. ATS.TR.220 Application of wake turbulence separation from Reg. EC 2017/373 Annex IV Part-ATS.

The Time-Based PWS-D 96x96 criteria used in validation exercises were draft rules which need to be matured and approved prior to implementation. To support the regulatory approval process, there is the need to put in place the required safety case.

Standardisation Framework Considerations

N/A

Solution Data pack

Solution PJ.02-01-06 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];

[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.

- 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).