

D1.4 - SESAR 2020 VLD3- W2-SORT DEMO Report - Part II - Safety Assessment Report (SAR) - WP02/WP04

Deliverable ID:	D1.4
Dissemination Level:	PU
Project Acronym:	SORT
Grant:	874520
Call:	H2020-SESAR-2029-1
Topic:	SESAR-IR-VLD-WAVE2-16-2019
Consortium Coordinator:	NLR (AT-One)
Edition Date:	24 May 2023
Edition:	00.03.00
Template Edition:	00.00.04

Authoring & Approval

Authors of the document

Beneficiary	Date
NATS	06/04/2023

Reviewers internal to the project

Beneficiary	Date
NLR (AT-ONE)	06/04/2023

Reviewers external to the project

Beneficiary	Date
None	06/04/2023

Approved for submission to the S3JU By - Representatives of all beneficiaries involved in the project

Beneficiary	Date
NLR (AT-One)	06/04/2023
LFV (COOPANS)	06/04/2023
SINTEF (NATMIG)	06/04/2023
SWEDAVIA	06/04/2023
ACG (COOPANS)	06/04/2023
DLR (AT-One)	06/04/2023
EUROCONTROL	06/04/2023
NATS	06/04/2023
HAL	06/04/2023

Rejected By - Representatives of beneficiaries involved in the project

Beneficiary	Date
None	03/03/2023

Document History

Edition	Date	Status	Beneficiary	Justification
00.01.01	06/04/2023	Initial draft	NATS	Distribution of first draft
00.01.02	11/04/2023	Reviewed Draft	(NLR AT-One)	Internal Review
00.01.03	14/04/2023	Updated draft	NATS	NLR Review comments addressed by NATS
00.02.00	17.04.2023	Issue approved for submission	NLR (AT-One)	Submitted second D1.4 version to SJU
00.03.00	24/05/2023	Final SJU approved issue	NLR (AT-One)	Version approved by all project partners and SJU.

Copyright Statement © (2023) – (BENEFICIARY OR BENEFICIARIES). All rights reserved. Licensed to SESAR3 Joint Undertaking under conditions.

SORT

VLD3 SAFELY OPTIMISED RUNWAY THROUGHPUT

This DEMO Report Part II Safety Assessment Report (SAR) for WP2/WP4 is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874520 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document constitutes the DEMO Report-Part II Safety Assessment Report for WP2/WP4, hence is part of the contractual deliverable D1.4 (DEMOR). This document specifies the safety assessment activities that have been carried out in SESAR 2020 Wave 2 by Project VLD3-W2-SORT in Work Package 02/04 exercise (EXE-VLD-03-001C) Optimized wake separation for arrivals with Minimum Radar Separation (MRS) and enhanced Runway Occupancy Time (ROT) simulations.

Table of Contents

Abstract	4
1 Executive Summary.....	6
2 Introduction.....	7
2.1 VLD Objectives and Justification.....	7
2.2 Scope of the VLD Safety Assessment	8
3 VLD Safety Argument and Assurance Activities.....	9
3.1 Introduction	9
3.2 Safety Criteria.....	9
3.3 Demonstration Objectives and Success Criteria	9
4 VLD Safety Results	11
4.1 Suitability of the SESAR Solution(s) for Deployment	11
4.2 Controller Feedback.....	11
4.3 Safety Impact of the VLD on Current Operations.....	15
4.4 Assessment against Success Criteria	15
5 Acronyms and Terminology.....	17
6 References	19

List of Tables

Table 1: Demonstration Objectives and Success Criteria.....	10
Table 2: Summary of technical losses of MRS.....	14
Table 2: General Safety Impact - Responses	15
Table 3: Assessment against Objectives.....	16
Table 4: Acronyms	18
Table 5: Glossary of terms.....	18

List of Figures

Figure 1: Interface and Procedures	12
Figure 2: LoS in relation to Indicators	12
Figure 3: Likelihood of LoS.....	13
Figure 4: Safety Impact.....	14

1 Executive Summary

This document is the Safety Report for the VLD-03-001C Exercise under WP2/WP4 of the SESAR 2020 VLD3-W2-SORT project, which is a Very Large Demonstration (VLD) of the Intelligent Approach Pairwise (IA PWS) Arrivals solution using Heathrow airport approach as the representative environment.

The safety assurance activities in this Safety Assurance Report (SAR) are in accordance with safety assurance strategy defined within the SORT Demo Plan [1] Section 5.1.1 and the Safety Assessment Plan (SAP) [2] Section 4.3. The objective is to demonstrate the solutions as implemented and assessed during the DEMO exercises do not create any new or significant safety issues.

The present document details the safety assessment activities that were carried out for exercise EXE-VLD-03-001C, that was executed as simulator trials at the NATS Corporate Technical Centre (CTC) building in Fareham, UK. The trials were carried out on the 23rd, 24th, 28th and 29th of March 2023.

The overall findings of this Safety Report are positive with no major safety issues having been identified. Further, all Demonstration Success Criteria relating to Safety have been met.

2 Introduction

This document is the Safety Report for the VLD-03-001C Exercise under WP2/WP4 of the SESAR 2020 VLD3-W2-SORT project, which is a trial demonstration of IA PWS. It was conducted as simulator trials at the NATS Corporate Technical Centre (CTC) building in Fareham, UK.

The demonstration was performed using valid air traffic controllers on Heathrow approach sectors to assess the IA PWS tool's functionality and interoperability with supporting systems.

The Safety Analysis produced general controller feedback relating to the viability of the concept from a safety point of view. Thus, the questions were not specific to the operational environment of Heathrow Airport. For a future implementation, such safety questions would need to be tailored to the specific operational environment being considered for implementation along with the requirements having to be completed by performing a Preliminary System Safety Assessment (PSSA).

2.1 VLD Objectives and Justification

As detailed within the VLD3-W2-SORT Demo Plan, Part 1 [1], the overall safety objective was to demonstrate that the functional system delivers the expected safety performance and does not result in new safety issues.

The VLD aimed to demonstrate the ability to manage multiple complex optimised separation and spacing constraints in various meteorological conditions. The demonstration included RECAT-EU-PWS Time Based and Static Pairwise wake categorisations with particular focus on the management of ROT and the reduction of MRS to 2NM.

The following solutions have previously been validated separately:

- AO-0328 (PJ02.01-01) - Wake turbulence separation optimisation
- AO-0306 (PJ.02-01-04) - Minimum pair separation based on Required Surveillance Performance.
- AO-0309 (PJ.02-03) - Minimum Radar Separation (MRS) based upon Required Surveillance Performance.
- AO-0337 (PJ.02-08-03) - Reduced separation based on local Runway Occupancy Time (ROT) characterisation.

Therefore, it was necessary to run them as one solution in a representative environment to demonstrate that there are no negative safety implications.

VLD consisted of the following exercise:

EXE-VLD-03-001C – Optimised wake separation minima for arrivals with reduced MRS and enhanced ROT

This exercise involved a Real Time Simulation (RTS) using approach traffic (based on recorded traffic data of pressured runway operations) in the NATS simulator using the pre-deployment Leidos tool. The exercise used with both the Reference and Solution scenarios so that a comparison could be made. A number of Success Criteria are associated with EXE-VLD-03-001C, which are covered in Section 3.3.

2.2 Scope of the VLD Safety Assessment

The scope of the Safety assessment covers the assurance evidence output from the Real Time Simulation (RTS) exercise activities on the IA PWS solution using Heathrow airport approach as the representative operation. Controller's surveys and feedback were used to assess the operation from a Safety point of view.

3 VLD Safety Argument and Assurance Activities

3.1 Introduction

For exercise EXE-VLD-03-001C, the Approach Controllers took part in multiple exercises using the IA PWS solution, with the intent of demonstrating the feasibility of the combined solutions and benefits over using the current operational version of eTBS, which uses RECAT-EU Wake Turbulence Categorisation.

3.2 Safety Criteria

Safety Criteria (SAC) define the acceptable level of safety (i.e. accident and incident risk level) to be achieved by the Solution under assessment, considering the impact on the ATM/ANS functional system and its operation.

The individual SESAR solutions included the VLD activities have already completed their V3 validations. Therefore, there was no requirement to re-validate them during this demonstration. Subsequently, the success or failure of the RTS exercise activities were solely based on the ability to meet the Demonstration Objectives and Success Criteria, which are detailed below.

3.3 Demonstration Objectives and Success Criteria

The assessment in this report responds to the following Demonstration Objectives in the following criteria were established in the SORT DEMO Plan [1]:

Demonstration Objective	Demonstration Success Criteria
OBJ-VLD-03-001C-SAF To assess the impact of reduced MRS and PWS TBS on operational safety	CRT-VLD-03-001C-SAF-001 The number of missed approaches due to insufficient spacing is no greater than in current operations.
	CRT-VLD-03-001C-SAF-002 Interoperability evidence can be produced to confirm that the elements of all solutions when combined do not degrade the level of safety.
	CRT-VLD-03-001C-SAF-003 The combined solution and procedures cause no losses of separation in the demonstration exercise.
	CRT-VLD-03-001C-SAF-004 The combined solution and procedures cause no increase in the frequency of go arounds when compared to the reference scenario.

Demonstration Objective	Demonstration Success Criteria
	For the purpose of this exercise it is assumed that the go arounds are covered by CRT-VLD-03-001C-SAF-001 above, which covers missed approaches.

Table 1: Demonstration Objectives and Success Criteria

4 VLD Safety Results

4.1 Suitability of the SESAR Solution(s) for Deployment

The ATCOs confirmed that the level of safety during the demonstration was acceptable with no significant issues being reported. Subsequently the demonstration objective has been met.

The safety questions did not explicitly ask for the number of missed approaches during the RTS for the purpose of comparing it to real Heathrow operations. The reason for this is that missed approaches in the current operation may be driven by a multitude of factors that cannot be realistically simulated, such as slow traffic vacating the runway and unstable approaches. Instead, the approach that was taken to meet the safety criteria CRT-VLD-03-001C-SAF-001 was to ask the controllers if they believed the number infrequent/abnormal scenarios would increase because of the use of the IA PWS concept, and then subsequently asking them to elaborate on this issue. There were no controller reports that suggested that missed approaches/go arounds would be affected.

4.2 Controller Feedback

4.2.1 Questionnaires

This assessment has assessed the safety related questions and has considered the results from the Sector Participants. The questions have not been broken down by run.

Except for three essay-style questions, the questions were in a multiple-choice format with up to three options. Where half or more of the responses from the controller group selected favourable results, the overall status of the question has been marked as OK.

The questions addressed the following three key areas:

- User Interface and Procedures ([Section 4.2.2](#))
- Loss of Separation ([Section 4.2.3](#))
- Genreal Safety Impact ([Section 4.2.4](#))

4.2.2 User Interface and Procedures

Status: OK

The purpose of the general safety questions was to assess the controller's views on tool concept and functionality. Subsequently the questions focus on the interface and basic procedures (It is noted that there is some overlap with the Human Factors (HF) assessment).

As can be seen in Figure 1 below, the results are overwhelmingly positive. Negative responses are generally associated with the specific scenario not having been seen by a controller.

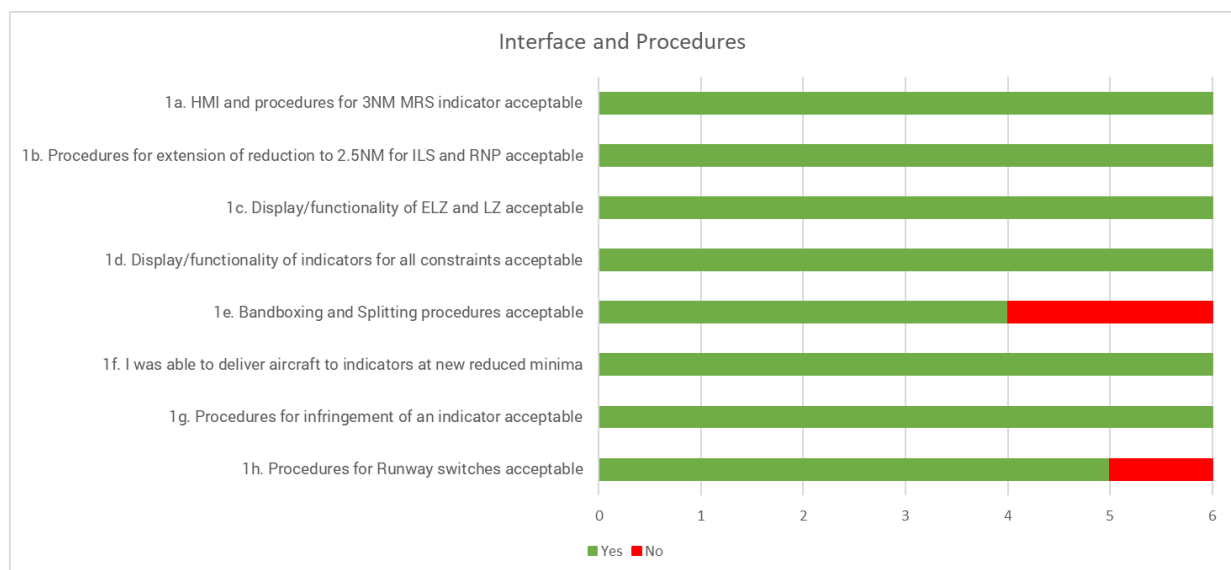


Figure 1: Interface and Procedures

4.2.3 Loss of Separation

Status: OK

The purpose of the questions relating to Loss of Separation (LoS) was to understand how LoS would be affected compared to the current operation. Therefore, the questions focused on the flight segments where the indicators would be shown, as this is where the concept primarily differs from eTBS.

In general the feedback relating to LoS was positive with no LoS being recorded in relation to the indicator positions. The controller remarks were as follows:

- *I don't recall any losses.*
- *I can't confirm if I did, but I have previously mentioned what I think can happen.*

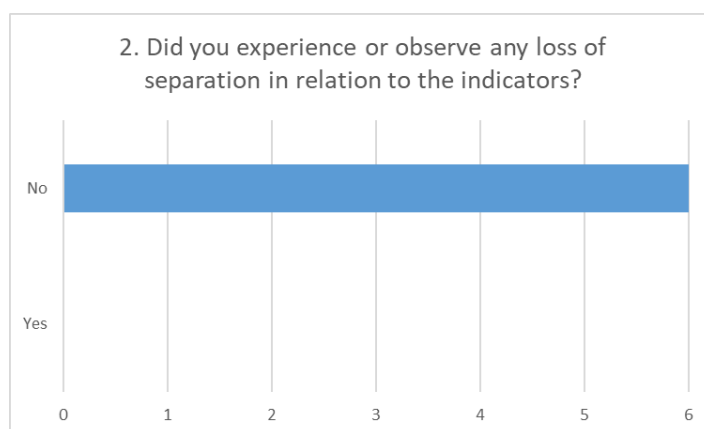


Figure 2: LoS in relation to Indicators

Consecutive Runway Switch

Procedures have been written (in coordination with Safety) for two consecutive switches which will be safety assured. The first aircraft should be switched over, and then when indicator is displayed the second aircraft would be switched over while still applying the rules for indicator infringement. During the operational scenario days a blocked runway was simulated where consecutive runway switches were tested. Whilst the controllers did not have any negative feedback about the defined procedures for consecutive switches, the scenario did raise discussions regarding the infringement procedures when an aircraft is 0.5NM ahead of an indicator and requires breaking off the approach (refer to section that discuss results for the acceptability of the procedures).

Potential Increase of LoS

When asked whether the concept would increase the number of LoS the results were mostly positive.

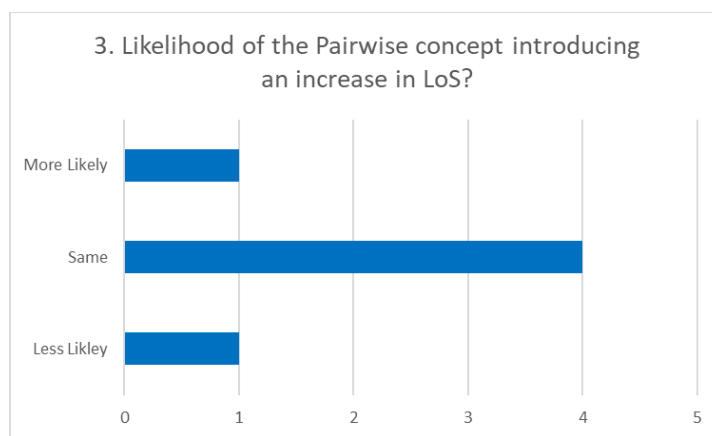


Figure 3: Likelihood of LoS

The controller remarks were as follows:

- *Indicators for MRS. We don't have in today's operation.*
- *I think it is a safe system but the fact we are trying to get aircraft as close of possible means in my opinion, it will not be (stet) more or less safe.*
- *Fine.*
- *I can't see a change based on following the procedures and ATCOs continuing to operate with the fundamentals of separation in mind.*
- *Previously mentioned.*
- *Potential for controllers to utilise bolder base legs when they are trying to achieve <3 mile spacing.*

The questions above addressed LoS during Pairwise operations. As detailed in Section A3.2.2 in the VLD DEMO Report [3] there were 11 technical LOS during the eTBS runs.

Category	eTBS Count	Pairwise Count
Leader on intercept, follower on base leg	9	0
Both aircraft on base leg to intercept	1	0
Both aircraft on final approach	1	0

Table 2: Summary of technical losses of MRS

There was a total of 11 technical losses of MRS during the eTBS runs while there were 0 technical losses in the PWS runs using the new MRS rules.

Through expert judgement, it was identified that in all but one case of the eTBS losses; the event would not have triggered a loss under the new Pairwise MRS procedures if aircraft had been positioned in the same way. Based on this analysis, it can be determined that the delivery of aircraft to separation minima is acceptable under the Pairwise solution.

4.2.4 General Safety Impact

Status: OK

The remaining questions were open-ended to attempted to explore any aspect of the design that the controller may perceive to be potentially safety related.

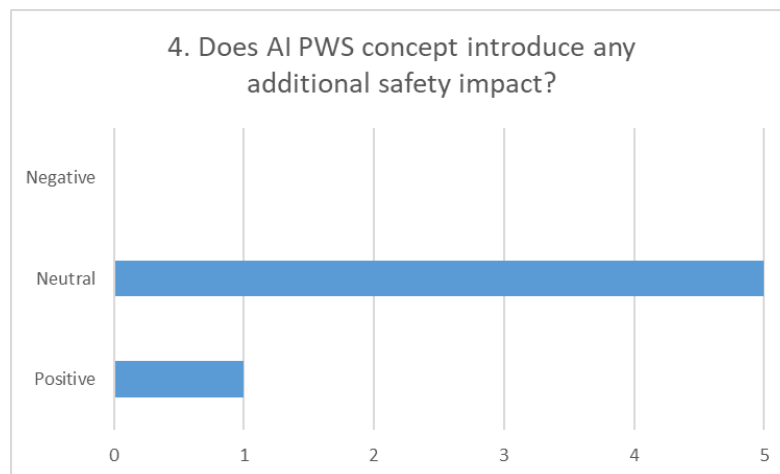


Figure 4: Safety Impact

There was no negative feedback with regards to the general safety impact question. Remarks were as follows:

- *Guaranteeing 2nm to threshold, mrs indicators outside 20nm*
- *I think it is as safe as things now.*
- *Fine*
- *I'm not sure the sim environment is a perfect reflection of real life. I couldn't answer until see in real world.*

- See previous about loss of 2.5nm
- Has the potential to reduce safety incidents because the indicator allows you to acquire the suitability of your base leg more quickly with the pairs of aircraft that are close to MRS.

The following essay style questions were asked regarding General potential Safety Impact:

Question	Results
5. Based on your operational experience, are there any specific scenarios where safety could be compromised using Pairwise?	All six controllers answered 'No'
6. Are there any additional changes required to ATC procedures that could improve safety?	Two controllers answered 'No' Remarks were as follows: <i>A thorough training package.</i> <i>Speed control awareness to airlines.</i> <i>Not procedural but needs to be covered in training</i> <i>Perhaps the INTs descending aircraft to 5000ft only to allow FIN to play around with the levels more.</i>
7. Are there any unusual/infrequent scenarios where a failure of the tool could have a negative safety impact?	Two controllers answered 'No' Remarks were as follows: <i>Potential outliers. But my understanding is that many have been discussed and captured in CONOPS.</i> <i>Other than INT vectoring an aircraft onto the localiser and keeping the strip. Potential for inaccurate line 0 information in this scenario.</i>

Table 3: General Safety Impact - Responses

4.3 Safety Impact of the VLD on Current Operations

As can be determined from the controller feedback in Questions 7 and 8, they recommend a comprehensive training packcade for ATCOs and speed control awareness to airlines.

4.4 Assessment against Success Criteria

The following safety related Success Criteria are applicable to this assessment, and have been extracted from the SORT Demo Plan [1] Section 5.1.3:

Demonstration Objective	Demonstration Success Criteria	Status
OBJ-VLD-03-001C-SAF	CRT-VLD-03-001C-SAF-001	Met. The participating ATCOs did not indicate that missed approaches would be affected.

Demonstration Objective	Demonstration Success Criteria	Status
To assess the impact of reduced MRS and PWS TBS on operational safety	The number of missed approaches due to insufficient spacing is no greater than in currently operations	
	CRT-VLD-03-001C-SAF-002 Interoperability evidence can be produced to confirm that the elements of all solutions when combined do not degrade the level of safety.	Met. The overall view from the ATCOs was that the interoperability of the solutions did not degrade safety.
	CRT-VLD-03-001C-SAF-003 The combined solution and procedures cause no losses of separation in the demonstration exercise	Met. The ATCOs did not report an any LoS associated with PWS using the new MRS rules. There were 11 technical losses of MRS during the eTBS runs. Through expert judgement, it was identified that in all but one case of the eTBS losses; the event would not have triggered a loss under the new Pairwise MRS procedures if aircraft had been positioned in the same way. Based on this analysis, it can be determined that the delivery of aircraft to separation minima is acceptable under the Pairwise solution.
	CRT-VLD-03-001C-SAF-004 The combined solution and procedures cause no increase in the frequency of go arounds when compared to the reference scenario	See CRT-VLD-03-001C-SAF-001 above

Table 4: Assessment against Objectives

5 Acronyms and Terminology

Acronym	Definition
ANS	Air Navigation Service
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ConOps	Concept of Operations
CTC	Corporate and Technical Centre
DEMO	DEMOstration
DEMOR	Demonstration Report
EFPS	Electronic Flight Progress Strips / System
eTBS	enhanced Time Based Separation
FAT	Factory Acceptance Test
IA	Intelligent Approach
LoS	Loss of Separation
MRS	Minimum Radar Separation
NOK	Not OK
OI	Operational Improvement
PMB	Project Management Board
PSSA	Preliminary System Safety Assessment
PWS	Pairwise
ROT	Runway Occupancy Time
RTS	Real Time Simulation
SAR	Safety Assurance Report
SJU	SESAR Joint Undertaking
SORT	Safely Optimised Runway Throughput
TBS	Time Based Separation

Acronym	Definition
VLD	Very Large Demonstration
W	Wave
WP	Work Package

Table 5: Acronyms

Term	Definition
RECAT EU	Wake Turbulence Re-categorisation, or Wake RECAT, is the safe decrease in separation standards between certain aircraft.

Table 6: Glossary of terms

6 References

Safety

- [1] SESAR2020 VLD3-W2- SORT D1.1 DEMO Plan Part I, Edition 00.03.00, issued as D1.1.04, 10 February 2023.
- [2] SESAR2020 VLD3-W2- SORT D1.1 DEMO Plan Part II Safety Assessment Plan – WP02/04 Edition 00.03.00, issued as D1.1.04, 10 February 2023.
- [3] D1.4 - SESAR 2020 VLD3-W2-SORT DEMO Report - Part I - VLD3-W2-SORT Edition 00.02.00, 16 April 2023
- [4] SESAR Safety Reference Material - latest edition accessible in STELLAR Program Library
- [5] Guidance to Apply SESAR Safety Reference Material - latest edition accessible in STELLAR Program Library

-END OF DOCUMENT-