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VLD3-W2-SORT-WP2

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Abstract

This document constitutes the DEMO Report-Part III Human Performance Assessment Report (HPAR) for WP2/WP4, hence is part of the contractual deliverable D1.4 (DEMOR). It contains the Human Performance (HP) assessment report for VLD3-W2-SORT-WP2 (Safely Optimised Runway Throughput) which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues, and the HP recommendations & requirements. It corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step 4 – Collate findings & conclude on transition to next V-phase.

The focus of VLD3-W2-SORT-WP2 is on demonstrating the TRL capabilities of the SESAR PJ.02-01-01, PJ.02-01-04, PJ.02-01-07, PJ.02-03, PJ.02-08-03 solutions, all aimed to safely optimise the runway throughput. The VLD3 project initially consisted of four different exercises executed in four different work packages (WP). This HPAR only provides details of HP activities conducted for WP02. The exercises for WP02 were run as a Real Time Simulation (RTS) using London Heathrow Airport (LHR) as the exemplar airport.

The evidence collected during the exercises indicated that the concept has partially achieved a V3 maturity level.

7 recommendations and 15 requirements have been generated.

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1 Executive Summary

This Human Performance Assessment Report (HPAR) summarises the results of the completed HF activities for VLD3-W2-SORT-WP2. They follow an amended set to those described in the Human Performance Assessment Plan (HPAP) as the scope of the project changed.

The main HP areas of interest from the HPAP were in accordance with the following HP Arguments:

- 1.1.2: The description of roles & responsibilities covers all tasks to be performed by a human actor.
- 1.2.1: Operating methods cover operations in normal operating conditions.
- 1.2.2: Operating methods cover operations in abnormal operating conditions.
- 1.2.3: Operating methods cover degraded modes of the ATM system.
- 1.2.5: Operating methods can be followed in an accurate, efficient, and timely manner.
- 1.3.2: Tasks can be achieved in a timely manner.
- 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.
- 1.3.4: The level of trust in the new concept/the new procedures is appropriate.
- 1.3.5: Human actors can maintain a sufficient level of situation awareness.
- 2.1.1: Changes to the task allocation between human and machine support human performance.
- 2.2.1: The accuracy of information provided by the system is adequate for carrying out the task.
- 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.
- 2.3.4: Alarms and alerts have been developed according to HF principles.
- 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable.
- 4.2.1: Knowledge, skill and experience requirements for human actors have been identified.

Evidence was gathered using both qualitative and quantitative methods during simulations and discussions by HP subject matter experts.

From a Human Performance perspective, the overall conclusion drawn from the evidence gathered is that the concept is feasible but requires further refinements being made to some components of the ATM system (i.e., technology, system design and people) and reassessing the impact on HP to improve confidence that the results are accurate and reliable.

To assist the next phase of development address open benefits and issues, 7 recommendations and 15 requirements have been generated.

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2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the result of the activities conducted according to the Human Performance (HP) assessment process (ref 1) in order to derive the HP assessment report for VLD3-W2-SORT-WP2 including requirements and recommendations.

2.2 Intended readership

The intended audience for this document is primarily all the partners involved in the VLD3-W2-SORT project.

[Internal to SESAR2020 and VLD3-W2-SORT.](#)

- Provide the human performance report for WP2 demonstration exercises.

[External to SESAR2020 and VLD3 SORT.](#)

- ANSPs - Learn about benefits of Pairwise Time-Based Separation with improved ROT management and support for reduced MRS, as well as on advantages and implication of the Integrated Runway Sequence Function and concept. Furthermore, learn about the safety gains and potential capacity gains that can be brought along by the installation of wake decay enhancing devices.
- Airports – Learn about benefits of Pairwise Time-Based Separation with improved ROT management and support for reduced MRS, as well as on the implication of the Integrated Runway Sequence Function and concept. Furthermore, they can learn about the safety gains and potential capacity gains that the wake decay enhancing devices installed in the approach area of an airport potentially could make available.
- Airlines – Learn about the benefits of Pairwise Time-Based Separation, particularly with regards to the improved ROT management and support for reduced MRS, while demonstrating the value of complying with ATC speed instructions on final approach and vacating the runway as soon as operationally possible, and on the potential arrival and departure implications of the Integrated Runway Sequence concept, as well as on the wake decay enhancing plate line installation.
- SESAR partners – interest in the demonstration of the concept and provision of evidence on the impact upon landing rates.

2.3 Structure of the document

This document corresponds to Part IV of the Demonstration Report (DEMOR). It describes changes, if any, to the content of the Human Performance Assessment Plan (HPAP, ref 2) and describes the results of the Human Performance assessment work for the solution.

2.4 Acronyms and Terminology

Term	Description
Human Factors (HF)	HF is used to denote aspects that influence a human's capability to accomplish tasks and meet job requirements. These can be external to the human (e.g., light & noise conditions at the workplace) or internal (e.g., fatigue). In this way, "Human Factors" can be considered as <i>focussing on the variables that determine Human Performance</i> .
Human Performance (HP)	HP is used to denote the human capability to successfully accomplish tasks and meet job requirements. In this way, "Human Performance" can be considered as <i>focussing on the observable result of human activity in a work context</i> . Human Performance is a function of Human Factors (see above). It also depends on aspects related to Recruitment, Training, Competence, and Staffing (RTCS) as well as Social Factors and Change Management.
HP activity	An HP activity is an evidence-gathering activity carried out as part of Step 3 of the HP assessment process. An HP activity can relate to, among others, task analyses, cognitive walkthroughs, and experimental studies.
HP argument	An HP argument is an HP claim that needs to be proven through the HP Assessment Process.
HP assessment	An HP assessment is the documented result of applying the HP assessment process to the SESAR Solution-level. HP assessments provide the input for the HP case.
HP assessment process	The HP assessment process is the process by which HP aspects related to the proposed changes in SESAR are identified and addressed. The development of this process constitutes the scope of Project 16.04.01. It covers the conduct of HP assessments on the Solution-level as well as the HP case building over larger clusters of Solutions.
HP benefit	An HP benefit relates to those aspects of the proposed ATM concept that are likely to have a positive impact on human performance.
HP case	An HP case is the documented result of combining HP assessments from Solutions into larger clusters (SESAR Projects, deployment packages) in SESAR.

HP issue	An HP issue relates to those aspects in the ATM concept that need to be resolved before the proposed change can deliver the intended positive effects on Human Performance.
HP impact	An HP impact relates to the effect of the proposed solution on the human operator. Impacts can be positive (i.e., leading to an increase in Human Performance) or negative (leading to a decrease in Human Performance).
HP recommendations	HP recommendations propose means for mitigating HP issues related to a specific operational or technical change. HF recommendations are proposals that require additional analysis (i.e., refinement and validation). Once this additional analysis is performed, HF recommendations may be transformed into HF requirements.
HP requirements	HP requirements are statements that specify required characteristics of a solution from an HF point of view. HP requirements should be integrated into the DOD, OSED, SPR, or specifications. HF requirements can be seen as the stable result of the HF contribution to the Solution, leading to a redefinition of the operational concept or the specification of the technical solution.
AMAN	Arrivals Manager
ANSP	Air Navigation Service Provider
APP	Approach
ATCO	Air Traffic Controller
ATM	Air Traffic Monitor/Air Traffic Management
CDA	Continuous Descent Approach
CONOPS	Concept of Operations
DBS	Distance Based Separation
DEMOR	Demonstration Report
EFPS	Electronic Flight Progress Strip
ELZ	Early Line Zero
EOP	End of Participation
EOR	End of Run

eTBS	Enhanced Time-Based Separation
EXCDS	EXtended Computer Display System – The electronic strip display in APP
FMECA	Failure Modes Effects Critical Analysis
FIN	Final Approach Controller
GS	Group Supervisor
HMI	Human-Machine Interaction
HPAP	Human Performance Assessment Plan
IA	Intelligent Approach
INT	Intermediate Approach Controller
LHR	London Heathrow Airport
LZ	Line Zero
MRS	Minimum Radar Separation
NM	Nautical Miles
N/A	Not applicable
PMB	Project Management Board
PWS	Pairwise
ROT	Runway Occupancy Time
RTS	Real Time Simulation
SA	Situation Awareness
SJU	SESAR Joint Undertaking
SME	Subject Matter Expert
SORT	Safely Optimised Runway Throughput
TBC	To be confirmed

TBS	Time Based Separation
TRL	Technology Readiness Level
TWR	Tower
VLD	Very Large-Scale Demonstrator
WL	Workload
WP	Work Package

Table 1: Acronyms and terminology

3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP assessment process described in detail in Human Performance Guidance document is to ensure that HP aspects related to SESAR DEMO technical and operational developments are systematically identified and managed. The SESAR HP assessment process uses an ‘argument’ and ‘evidence’ approach. An HP argument is an ‘HP claim that needs to be proven’. The aim of the HP assessment is to provide the necessary ‘evidence’ to show that the HP arguments impacted have been considered and satisfied by the HP assessment process. This includes the identification of HP requirements and recommendations to support the design and development of the concept, which will be defined in the HP Assessment Report

The HP assessment process is a four-step process. Figure 1 provides an overview of these four steps with the tasks to be carried out and the two main outputs (i.e., HP plan and HP assessment report). In addition, an HP Log is recommended to be maintained throughout the lifecycle of the DEMO in which all the data/ information obtained from all HP activities conducted as part of the HP assessment is documented. It was agreed in V2 that no HP Log was necessary.

For the VLD the main objective is to demonstrate the benefits of the concept to ATCOs and stakeholders. The HP assessment at this level (referred to as V3+ in the Human Performance Guidelines document) aims primarily at bridging the gap between the V3 validation phase and deployment.

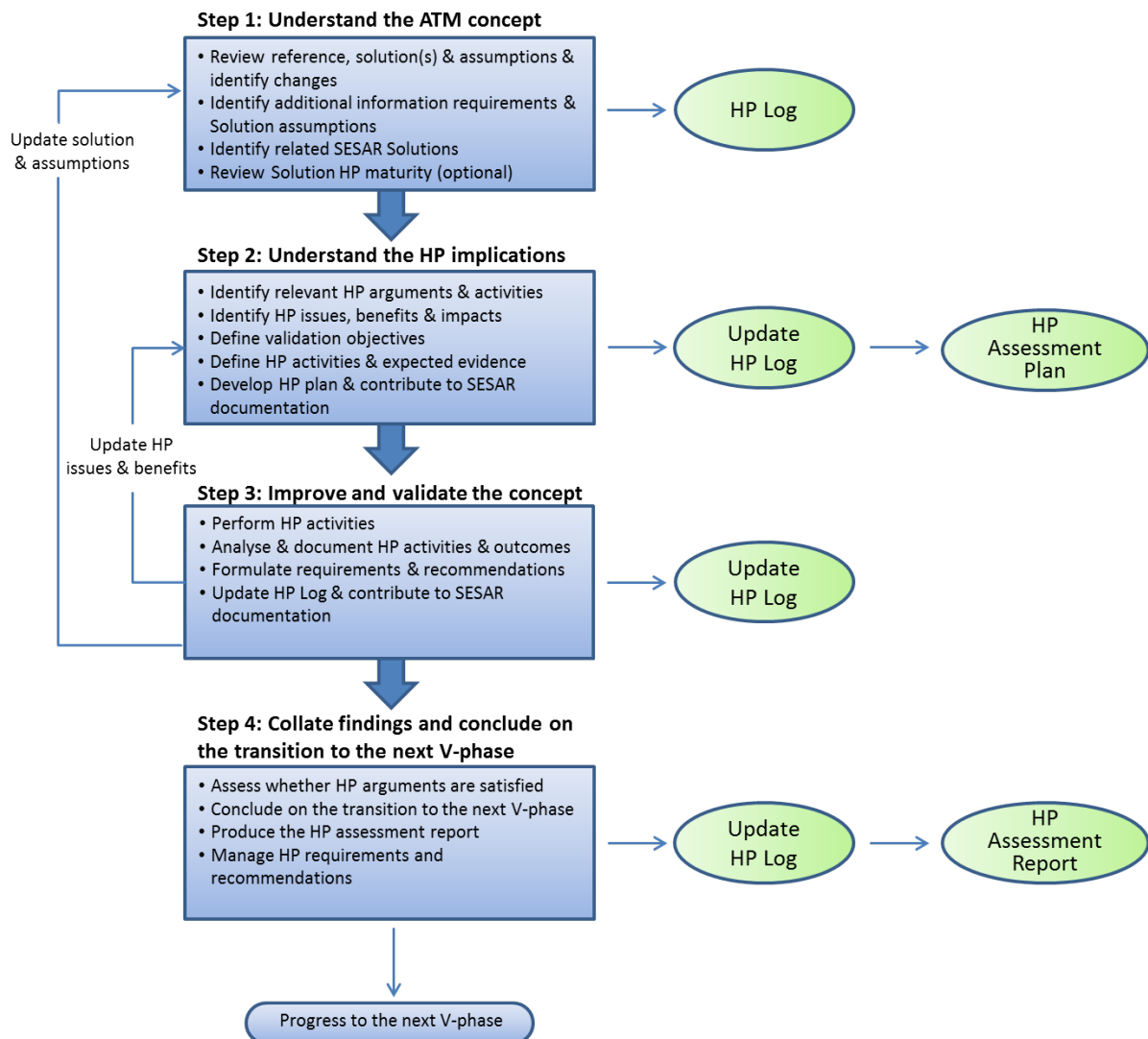


Figure 1: Steps of the HP Assessment Process

4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

A reference scenario of controllers utilising eTBS under existing ATC procedures and in normal operating conditions will be assessed during the real time simulation activity. This will be compared against the solution scenario with controllers using the IA Platform to define and quantify the benefits created.

4.1.1 Description of reference scenario

The reference scenario using eTBS supports the display of indicators for wake separation pairs, and ROT behind Upper, Heavy and Super aircraft where ROT is the largest constraint relative to the wake separation whereas indicator types for all separation/spacing constraints are supported by the solution scenario.

Specific details of the demonstration design are contained within DEMOR Part I (ref 3).

4.1.2 Description of solution scenario

The SORT project management board (PMB) in support of the SJU decided to re-scope the WP02 demonstration exercise at Heathrow airport into a pre-deployment RTS. The original plan consisted of the Shadowing Approach Controller (non-operational position) listening in to the frequency, marking the EFPS appropriately and assessing the suitability of the IA indicators on final approach as generated to Pairwise Wake Categorisation and under the reduced radar separation. The drawback to this method is that the controller would just be assessing the position of the indicators and would not be able to manipulate the traffic at all.

The revised proposal was to run the approach traffic (based on recorded traffic data of pressured runway operations) in the NATS simulator using the pre-deployment Leidos tool so that we can properly address the approach deliverability aspects, which would not be possible in the Shadow mode proposal.

Specific details of the demonstration design are contained within DEMOR Part I (ref 3).

4.1.3 Consolidated list of assumptions

Solution specific assumptions are provided in the DEMOP Part I (ref 4). There were no assumptions generated during the HP assessment.

4.1.4 List of related SESAR Solutions to be considered in the HP assessment

See section 3.2 of the DEMOR Part I (ref 3) for details.

4.1.5 Identification of the nature of the change

See section 3.16 of the Human Performance Assessment Plan (HPAP).

4.2 Step 2 Understand the HP implications

4.2.1 Identification of relevant arguments, HP issues & benefits and HP activities

A review of the issues identified in the HPAP was conducted by Subject Matter Experts prior to the Real Time Simulation (RTS). Table 2 describes the final list of issues that were deemed to be credible.

Argument	Issue ID	Issue Description
1.1.2: The description of roles & responsibilities covers all tasks to be performed by a human actor.	VLD3-WP2-HP-01	Additional responsibilities will be assigned to the Group Supervisor (Airports) to ensure the effective transition between different modes of operation is successful. Failing to include ALL tasks required for fulfilling these new responsibilities could lead to confusion, inadequate training/preparation for implementation and sub-optimal performance. This could then impact others' capabilities/performance level, operational safety, and runway throughput.
1.2.1: Operating methods cover operations in normal operating conditions.	VLD3-WP2-HP-02	New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to create such methods for all normal operating conditions could lead to forced human error, safety incidents and/or service delivery impairments.

1.2.2: Operating methods cover operations in abnormal operating conditions.	VLD3-WP2-HP-03	New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to create procedures that cover all abnormal operating conditions could lead to forced human error, safety incidents and/or service delivery impairments.
1.2.3: Operating methods cover degraded modes of the ATM system.	VLD3-WP2-HP-04	It is possible that at times tools will fail to work as intended. Impacted human actors need to know what to do in these circumstances. This is known as a fallback procedure. Failure to create appropriate fallback procedures could lead to forced human error, safety incidents and/or service delivery impairments.
1.2.5: Operating methods can be followed in an accurate, efficient, and timely manner.	VLD3-WP2-HP-05	New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to ensure that the procedures written can be enacted by ATCOs successfully could lead to human error driven safety incidences and reduced level of service delivery.
1.3.2: Tasks can be achieved in a timely manner.	VLD3-WP2-HP-06	New tasks are being allocated to ATCOs. Equally, the pre-existing tasks of coordination and maintaining separation standards will also be impacted by the concept. Failure to ensure that performance remains within acceptable parameters could lead to losses of separation and other safety incidents.
1.3.3: The level of workload (induced by cognitive and/or	VLD3-WP2-HP-07	Changes to ATCO tasks cause corresponding changes to the

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physical task demands) is acceptable.		type and amount of cognitive and/or physical demands placed upon them. Failure to ensure that the level of demand remains within acceptable parameters (e.g., variability, predictability, and flexibility of operational traffic patterns) could lead to a reduction in safety II behaviours. If the impact is significant and/or prolonged it could also lead to ATCOs not having sufficient resources to handle unexpected events such as emergencies. It could also lead to fatigue and fatigue-related human error.
1.3.4: The level of trust in the new concept/the new procedures is appropriate.	VLD3-WP2-HP-08	According to the Technology Acceptance Model, which constitutes a good basis for assessing human actors' trust in a system, two key motivating factors that dictate humans' willingness to accept and use new tools exist. These are the perceived usefulness of the tools and the perceived ease with which the tools can be used. Failure to ensure that these perceptions are positive can lead to controllers rejecting the tools thus negating any benefits that can be realised.
1.3.5: Human actors can maintain a sufficient level of situation awareness.	VLD3-WP2-HP-09	The concept's tool introduces new sensory information into the ATCO's environment. This new information needs to be successfully incorporated into controllers' decision-making process. This means that they must be able to perceive, comprehend and use the information to understand the current traffic patterns and

		predict how they may change in time and space. If they are unable to do one or more of these things, crucial information may be excluded from the decision-making process leading to an inappropriate action being taken.
2.1.1: Changes to the task allocation between human and machine support human performance.	VLD3-WP2-HP-10	The benefit of the tools within this concept is that they process information on behalf of the ATCO and then provides a possible solution. This should therefore enable controllers to use their attentional resources elsewhere, maintain spare capacity to handle unexpected events and switch between tasks more rapidly. However, failure to get the balance right could lead to confusion, loss of confidence, mistrust, and the negation of any benefits.
2.2.1: The accuracy of information provided by the system is adequate for carrying out the task.	VLD3-WP2-HP-11	Information provided by the system has to be sufficiently accurate for ATCOs to be confident that their decisions and plans are correct. Failure to ensure that the system is accurate could lead to human error and potentially a safety or service delivery problem.
2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.	VLD3-WP2-HP-12	ATCOS are responsible for resolving infringements. The quicker they can do this the better. Timeliness of information presented by the system to the controllers enables them to be proactive, which increases operational safety.

2.3.4: Alarms and alerts have been developed according to HF principles.	VLD3-WP2-HP-13	New alarms and alerts have been developed as part of the concept. Failure to develop that in accordance with HF principles (e.g., NATS Alerting Philosophy, ref) will result in human error/sub optimal performance and possibly safety incidents and reduced service delivery.
2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable.	VLD3-WP2-HP-14	According to the Technology Acceptance Model which constitutes a good basis for assessing human actors' trust in a system, two key motivating factors that dictate humans' willingness to accept and use new tools exist. One of these is the usability of the tools. Failure to ensure that the user interface is usable can lead to controllers rejecting the tools thus negating any benefits that can be realised. It can also lead to human error and therefore introduce a risk to safety and service delivery.
4.2.1: Knowledge, skill and experience requirements for human actors have been identified.	VLD3-WP2-HP-15	Introducing a higher level of automation means that there is normally less work for a controller to carry out. The potential risk this poses is that controllers become de-skilled in these areas. This could lead to human error or an inability for humans to act as a fallback to system failures, which could introduce a risk to operational safety.
	VLD3-WP2-HP-16	The rate and scale of change that and ATCO experiences can affect their ability to perform their jobs safely and effectively. The scale of change associated with this concept is

		very large for some. Failure to provide in-depth training that delivers the appropriate confidence and competence levels could lead to human error, which could introduce a risk to operational safety.
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Table 2: Arguments and associated HP Issues

All HP issues were assessed during Activity 6 – The Real Time Simulation.

4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

Originally six main HP activities were planned (see Section 1.4 of the HPAP). Details are provided below.

Activity 1. Change & Impact Assessment	
Description	This activity collated relevant information from previous SESAR produced documents to help build a picture of the potential impacts on humans.
Arguments & related issues addressed	All arguments were reassessed against the updated solution scenario to ensure that all relevant issues were captured See Table 2
HP objectives	N/A
Tools / Methods selected out of the HP repository	Subject Matter Expertise
Summary of the HP activity	A review of the concept against each argument to determine what, if any, changes were being made and on whom they impacted.

Table 3: Description of Activity 1

Activity 2. Integration of Concept	
Description	This activity aimed to identify what HP factors, if any, need to be considered when integrating the solutions into the target system and create requirements to ensure that integration is successful (i.e., operational safety and service delivery goals can still be achieved).
Arguments & related issues addressed	N/A

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HP objectives	N/A
Tools / Methods selected out of the HP repository	N/A
Summary of the HP activity	This activity was combined with Activity 6 – Real Time Simulation

Table 4: Description of Activity 2

Activity 3. Technical specification and feasibility assessments – Check compliance with HMI Design Standards	
Description	This activity gathered evidence to demonstrate that the design of the integrated system HMI (i.e., the solutions being investigated and the target system) complies with relevant design standards.
Arguments & related issues addressed	N/A
HP objectives	N/A
Tools / Methods selected out of the HP repository	N/A
Summary of the HP activity	This activity was combined with Activity 6 – Real Time Simulation

Table 5: Description of Activity 3

Activity 4. Transition feasibility assessment – Identify and mitigate potential HP related transition risks	
Description	This activity builds on the output of Activity 2 by understanding how the HP related transition factors may introduce risks to safety or service delivery and what steps need to be taken to mitigate them.
Arguments & related issues addressed	N/A
HP objectives	N/A
Tools / Methods selected out of the HP repository	N/A
Summary of the HP activity	This activity was combined with Activity 6 – Real Time Simulation

Table 6: Description of Activity 4

Activity 5. Benefits and risks assessment – Manage potential HP risks and benefits.	
Description	This activity finalised any HP related risks and benefit assessments.
Arguments & related issues addressed	All arguments were considered to ensure that the list of issues and benefits were as exhaustive as possible
HP objectives	See Table 9 (Section 4.4.1)
Tools / Methods selected out of the HP repository	Subject Matter Expertise
Summary of the HP activity	On 8 th of March 2023, three Human Factor Specialist discussed the VLD3 solution and based on their knowledge and experience reviewed the issues contained within the HPAP and generated new potential issues and benefits where appropriate. These were then fed into Activity 6.

Table 7: Description of Activity 5

Activity 6. Very Large Demonstration Real Time Simulation	
Description	A PWS RTS was run in March 2023 with six APP ATCOs and two TWR ATCOs to collect evidence about the potential impact of the VLD concept on human performance. A comparison was intended between data collected during this simulation (solution scenario) and data collected during an eTBS baseline simulation (reference scenario) run in February 2023.
Arguments & related issues addressed	All HP issues in Table 2
HP objectives	All HP objectives in Table 9
Tools / Methods selected out of the HP repository	Questionnaires, RTS debriefing, observations
Summary of the HP activity	Full details of the demonstration exercise are contained within section 3.3.1 of the DEMOR Part 1. Below is a summary of the HP specific aspects. Approach and Tower ATCOs completed End of Run and End of Participation Questionnaires, providing feedback on their perceived workload (average and peak), situational awareness, teamwork, overall concept acceptance and system acceptance using the two dimensions of the TAM (i.e., ease of use and usefulness), procedures

and HMI acceptability, tool support for task performance and transition factors, including training and skill fade.

Additional evidence was gathered via debriefs at the end of each run and through observations of the HF practitioner present during the RTS.

Table 8: Description of Activity 6

The March RTS activity consisted of two scenario days, one matched run day with the February eTBS baseline, and a final day with one perfectly matched PWS runs and eTBS baselines and one matched with February eTBS baseline. The initial RTS plan would have allowed for perfectly matched runs (design and ATCOs), which would in turn have ensured valid and reliable HP results. However, the initial matched RTS design was not achievable due to the ATCOs names that we were provided at the planning stage were different for some of the days when the actual roster came out. Then because of the issues found during testing with the software a decision was made to run the matched exercises on the final two days rather than the first two to allow some time for a software fix to be delivered. This further corrupted the matched design. Then finally, because of the ExCDS issues the ATCOs were instructed to use ExCDS making minimal inputs to reduce the lag and number of times the system crashed. However, because they weren't using ExCDS correctly this therefore invalidated the HP measures collected for all but the last day. Moreover, telephone communications were not available, and APP controllers stated that the controlling environment felt "sterile" and "not realistic". Additionally, multiple abnormal scenarios were run during scenario days, at a fast-paced rate substantially bringing workload up, which was equally not representative of real operations. In this regard, the purpose of the scenario days was less to assess human performance, but rather to test the system functionalities.

As such, the RTS setup did not holistically present enough fidelity to real operations and most of the quantitative HP data collected (i.e., workload, situation awareness, teamwork) was disregarded. The comparison between eTBS baseline (reference scenario) and PWS (solution scenario) data was discarded for the same reason. Although two perfectly matched runs were achieved with a working system, it was considered they would not be enough to provide reliable HP data comparisons. The majority of conclusions were therefore based on qualitative evidence, either from debriefs, discussions or questionnaires, and feature an associated degree of subjectivity.

Although not intended as a validation activity for TWR operations, a TWR Air Traffic Monitor (ATM) was emulated, and two tower controllers were present during the activities. However, the setup did not allow them to fully interact with the system and they were mostly observers, triggering scenarios for APP. They also reported that the ATM emulator did not feel realistic enough. Feedback from TWR controllers was gathered on user confidence, tool support, acceptability of procedures and indicators, but the same caveat on evidence subjectivity applies, especially considering the small sample size (n=2).

Lastly, controllers present for the RTS were part of the core development team and are already familiar with the concept. It is recommended that moving forward HP data also be collected from ATCOs without previous knowledge of or interaction with the concept tools.

4.4 Step 4 Collate findings & conclude on transition to next V-phase

4.4.1 Summary of HP activities results & recommendations / requirements

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
Arg. 1.1.1: The description of roles & responsibilities covers all affected human actors.							
Arg. 1.1.2: The description of roles & responsibilities covers all tasks to be performed by a human actor.							
VLD3-WP2-HP-01	Issue: Additional responsibilities will be assigned to the Group Supervisor (Airports) to ensure the effective transition between different modes of operation is successful. Failing to include ALL tasks required for fulfilling these new responsibilities could lead to confusion, inadequate training/preparation for implementation and sub-optimal performance. This could then impact others' capabilities/performance level, operational safety, and runway throughput.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	Though it was not intended to include the GS position in this RTS, it was possible to replicate the GS's expected input (i.e., spacing policies were added via a spare EXCDS terminal rather than through AMAN). Further clarification of the GS's responsibilities (e.g., interacting with the system or making phone calls to the controllers) is still needed, which should be investigated in the future phases of development. During RTS debriefs, APP controllers highlighted the importance for GSs to be considered in training, for them to understand how to better support the FIN, who according to them is expected to get more work.	N/A	VLD3-WP2-HP-RQT-01: The next phase of development shall define the GS's responsibilities with regards to this concept VLD3-WP2-HP-RQT-02: ANSPs shall include GSs in any training solutions regarding this concept
Arg. 1.1.3: Roles and responsibilities are clear and consistent (in V1: non-contradictory).							
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.							
VLD3-WP2-HP-02	Issue: New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to create such methods for all normal operating conditions could lead to forced human error, safety incidents and/or service delivery impairments.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1 OBJ-02.03-V2-VALP-HP1.2.1-001 OBJ-02.03-V2-VALP-HP1.2.1-002	Real Time Simulation	The results of the End-of-Participation questionnaire show that most APP controllers (66.7%, n=6) strongly agreed that indicators procedures are acceptable. Similarly, all APP controllers agreed that the Pairwise procedures and indicator support for transitioning to 2NM MRS on final approach enables them to achieve the required spacing or separation. As for TWR controllers (n=2), they strongly agreed that procedures for normal operations are satisfactory. However, a concern was raised about the line zero and the indicator pushing people to achieve minimal separation and ending up losing the 2.5nm separation in the base leg turn: "I have some concern about how easy it will be to lose 2.5nm separation in the turns from downwind onto base leg and to establish. The 2.5nm line zero and marker make it much	VLD3-WP2-HP-REC-01: The next phase of development should consider the potential benefit of INT transferring aircraft vertically separated to FIN as a standard procedure rather than by exception.	VLD3-WP2-HP-RQT-03: Indicator HMI and procedures should be designed as such that there is no increased risk in loss of separation

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					more enticing to try and achieve it. This needs to be highlighted during training” – this design of the procedure may prompt an unsafe behaviour. Additionally, FIN felt like receiving aircraft vertically separated from INT allowed them to manage the levels easier and be tighter when vectoring without fear of losing separation (e.g., INTs dropping to 5000ft). “Having vertical on FIN is a real advantage when wind conditions allow spacing to be reduced. This may result in less CDA's”. “I think having a standard drop to 5000ft downwind to give FIN the option to use vertical”.		
Arg. 1.2.2: Operating methods cover operations in abnormal operating conditions.							
VLD3-WP2-HP-03	Issue: New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to create procedures that cover all abnormal operating conditions could lead to forced human error, safety incidents and/or service delivery impairments.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	Multiple non-standard scenarios were simulated during the two scenarios days (e.g., breakoff, medical emergency etc.), for most of which operating methods and procedures were deemed acceptable by ATCOs. A scenario was observed on several occasions where aircraft lost code-callsign conversion causing the aircraft to become uncorrelated (this was caused by an unknown simulator issue). The result being that the tool does not generate an indicator for such aircraft and the ELZ for the following aircraft is suppressed, whereas the Line Zero is not. Some of the controllers did not feel comfortable with this tool behaviour and felt that there was a potential for information the tool displays to cause confusion. They felt that the Line Zero should also be suppressed as there is the potential for this aircraft to be turned early if the Controller does not have full situational awareness of the non-correlated flight. Therefore, it is recommended that this particular behaviour is highlighted in the Controller training and highlighted in the CONOPs	VLD3-WP2-HP-REC-02: ANSPs should ensure that the tool behaviour in any unusual/edge-case scenarios are highlighted in controller training and in the CONOPs.	N/A
Arg. 1.2.3: Operating methods cover degraded modes of the ATM system.							
VLD3-WP2-HP-04	Issue: It is possible that at times tools will fail to work as intended. Impacted human actors need to know what to do in these circumstances. This is known as a fallback procedure. Failure to create appropriate fallback procedures could lead to forced human error, safety incidents and/or service delivery impairments.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	Degraded conditions were not simulated in the RTS because the analysis of failure modes is incomplete. This is to be expected at the stage of concept development. Future phases of development need include an activity that identifies the impact all potential failures/degrade modes may have on end-users (e.g., a FMECA) to ensure operating methods cover everything they need to cover.	N/A	VLD3-WP2-HP-RQT-04: The next phase of development shall design an activity to assess the extent to which operating methods cover

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							degraded modes of the ATM system
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).							
Arg 1.2.5: Operating methods can be followed in an accurate, efficient, and timely manner.							
VLD3-WP2-HP-05	Issue: New operating methods relating to the appropriate application of the concept solutions will be needed. Failure to ensure that the procedures written can be enacted by ATCOs successfully could lead to human error driven safety incidences and reduced level of service delivery.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	Results of the EOP questionnaire suggest that all APP controllers agreed that they could follow the operating methods in a timely, efficient, and accurate manner for normal and abnormal operating conditions. Degraded conditions were not simulated in this RTS and thus controllers' ability to follow degraded mode operating conditions could not be assessed at this stage.	N/A	VLD3-WP2-Hp-RQT-05: The next phase of development shall assess the extent to which controllers can follow degraded mode operating methods, including fallback
Argument 1.3: Human actors can achieve their tasks (in normal & abnormal conditions of the operational environment and degraded modes of operation)							
Arg. 1.3.1: The potential for human error is reduced as far as possible.							
Argument 1.3.2: Tasks can be achieved in a timely manner.							
VLD3-WP2-HP-06	Issue: New tasks are being allocated to ATCOs. Equally, the pre-existing tasks of coordination and maintaining separation standards will also be impacted by the concept. Failure to ensure that performance remains within acceptable parameters could lead to losses of separation and other safety incidents.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	According to the EOP questionnaire results, ATCOs mostly considered that their ability to coordinate traffic and maintain separation would not be impacted by the concept. However, one controller highlighted the potential for losses of separation occurring more often when turning on base leg, when aiming for tighter spacings than in current operations.	N/A	VLD3-WP2-Hp-RQT-03: Indicator HMI and procedures should be designed as such that there is no increased risk in loss of separation
Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.							
VLD3-WP2-HP-07	Issue: Changes to ATCO tasks cause corresponding changes to the type and amount of cognitive and/or physical demands placed upon them. Failure to ensure that the level of demand remains within acceptable parameters (e.g., variability, predictability, and flexibility of operational traffic patterns) could lead to a reduction in safety II	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1 OBJ-02.03-V2-VALP-HP1.3.2-002	Real Time Simulation	Generally speaking, controllers didn't feel like WL would change very much (although it was pointed out during debriefs that it is likely the FIN would take on more work than the INT and support from the GS and INT would be preferable), but rather their focal point and SA. They considered that the tools make monitoring easier: "providing more support for the controller must be a good thing" and decrease task load. However, due to RTS limitations, ATCOs couldn't make a proper	VLD3-WP2-HP-REC-03: The next phase of development should further investigate the validity of the perception that the HMI design of the tools	VLD3-WP2-Hp-RQT-06: The next phase of development shall reassess the acceptability of

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	behaviours. If the impact is significant and/or prolonged it could also lead to ATCOs not having sufficient resources to handle unexpected events such as emergencies. It could also lead to fatigue and fatigue-related human error.		OBJ-02.03-V2-VALP-HP1.3.2-003 OBJ-02.03-V2-VALP-HP1.3.2-005 OBJ-02.03-V2-VALP-HP1.3.3-001 OBJ-02.03-V2-VALP-HP2.1.2-001		comparison between the PWS solution and the eTBS operations from baseline. Still, they stated that if the system was working well, it would have added in some workload, but they feel it would be normal and manageable. As expected, the most quoted workload driver was the design/operation of the SIM (n=5) (e.g., “Steady stream to stacks but without usual departures, phone calls and coordination of order workload in sim wasn’t really representative of that traffic loading in ops room”), followed by other traffic related aspects (i.e., presentation of traffic, levels, and complexity). Two controllers also stated that the HMI design of the tools and the operating techniques/procedures associated with the tools increased their workload. Therefore, further investigation is needed in future phases of development. As previously explained, the intention was to collect more quantitative information on workload via EOR questionnaires, but the shortcomings of the SIM rendered this data unreliable. Future phases of development should reassess the acceptability of controllers’ workload.	and the operating techniques/procedures associated with the tools increase controllers’ workload and whether than increase is acceptable (i.e. falls within the normal variability of workload levels)	controllers’ workload
Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.							
VLD3-WP2-HP-08	Issue: According to the Technology Acceptance Model (ref 5), which constitutes a good basis for assessing human actors’ trust in a system, two key motivating factors that dictate humans’ willingness to accept and use new tools exist. These are the perceived usefulness of the tools and the perceived ease with which the tools can be used. Failure to ensure that these perceptions are positive can lead to controllers rejecting the tools thus negating any benefits that can be realised.	OPEN	OBJ-02.03-V2-VALP-HP1.3.4-001	Real Time Simulation Subject Matter Expert Discussion	APP controllers agreed that the IA tools are good, useful tools overall, which most of them (67%, n=6) found easy to use, according to EOP responses. ATCOs also highlighted the benefit of the AMAN link, although that is still under development and was not validated during this activity. During debriefs ATCOs expressed concerns about the perceived benefit of the concept, particularly in relation to throughput increase in certain winds. For example, in light winds today, for minimum spacing aircraft pairs the controller will be ‘eyeballing’, whereas with Pairwise the controller is likely to deliver to the indicator, and potentially adding on +0.1/+0.2NM to be conservative therefore achieving roughly the same capacity. It was acknowledged that greater benefit will be seen in stronger winds. Although it was suggested that some experienced ATCOs today may be seen to be less efficient with Pairwise with having an indicator to aim for rather than ‘eyeballing’, it was acknowledged that those less experienced controllers who tend to be more conservative with their spacings will become more efficient with the indicator. Pairwise therefore may have the effect of making delivery across the cohort of controllers more consistent, and ‘flattening the curve’ of the range of delivery. In addition,	VLD3-WP2-HP-REC-04: The next phase of development should assess the validity of the perception that more than 0.5nm would be safer for breakthrough VLD3-WP2-HP-REC-05: The next phase of development should also collect HP data from ATCOs without previous knowledge of or interaction with the concept tools	VLD3-WP2-Hp-RQT-07: The next phase of development should better understand the mediating and moderating effects of controller attitudes on intention to use the concept as designed VLD3-WP2-Hp-RQT-08: The next phase of development shall check whether perceptions of inaccuracy of the



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					the presence of an indicator for all aircraft pairs will ultimately improve safety. During the RTS, it was observed that there were occasions when the aircraft were inside the indicator, but no recovery action was taken as it was not necessary since the system was being overly pessimistic with its calculations and the indicator would jump forward or the aircraft would pull away from the indicator as the leader passed 4DME. Therefore, ATCOs felt like system was misaligned with the whole point of optimization, which they found a bit frustrating. However, this behaviour could have been due to the either of the following reasons: • The aircraft speed profiles inside 4DME not being accurate in the simulator compared to operational data; • The system cap of 2.5NM on indicators being removed when the lead aircraft passed 4DME (note that this is correct system behaviour and as designed). If the design of the system is the reason for this behaviour and it becomes a noticeable trend, it could lead to controllers not taking recovery action when necessary due to prevalence and/or expectation bias. A comparison between the two perfectly matched runs of the last SIM Day and a fully working system yielded comments questioning the acceptance of the ATCOs: “Noticeably quieter using eTBS in comparison to PWS”, “Felt like a calmer run with eTBS over the PWS comparison run earlier”. Nevertheless, we acknowledge that the data is limited (only two opinions) and is based solely on two runs, therefore the reliability and validity are questionable. The next phase of development should further investigate this issue. One controller somewhat disagreed with the acceptability of the indicator support for wake breakthrough, stating: “I think we need more than 0.5nm for breakthrough. Maybe 0.75 as sometimes even today it isn't enough to recover at times.” However, coming from one controller this could be a result of individual risk perception rather than objective safety assessment. Furthermore, the wake breakthrough behaviours is the same as eTBS today rather than a change being introduced with the pairwise concept. From a TWR perspective, the change should just provide more consistency at threshold, which prompts an overall positive outlook on the system and the change. However, apparently at a wider scale ATCOs		LZ are due to the functionality of the system or due to the design of the SIM VLD3-WP2-Hp-RQT-09: The next phase of development shall fully include the TWR controller position in the design and assessment of the concept VLD3-WP2-Hp-RQT-10: If the system is overly pessimistic, the next phase of development should assess the extent to which controllers’ decisions are influenced by prevalence and/or expectation bias

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					in the TWR feel like the introduction of PWS will imply bringing in a lot of new aircraft much closer together, which makes them slightly reluctant. As explained by the TWR controllers present for the activity, that is most likely due to the fact that at this stage the wider controller pool doesn't understand the concept, which could be tackled through an educational piece. Further investigation of TWR controller acceptance is required, as these conclusions have been drawn based on input from only two controllers solely observing activities on an emulated ATM. Lastly, all controllers present for the RTS were part of the core development team, being already familiar with the concept. To avoid any bias in system acceptance, it is recommended that moving forward HP data also be collected from ATCOs without previous knowledge of or interaction with the concept tools.		
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.							
VLD3-WP2-HP-09	Issue: The concept's tool introduces new sensory information into the ATCO's environment. This new information needs to be successfully incorporated into controllers' decision-making process. This means that they must be able to perceive, comprehend and use the information to understand the current traffic patterns and predict how they may change in time and space. If they are unable to do one or more of these things, crucial information may be excluded from the decision-making process leading to an inappropriate action being taken.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.1	Real Time Simulation	During debriefs, controllers stated that having the ELZ indicator makes their controlling tasks easier in terms of judging the situation, making it more clear more quickly than just "eyeballing" it (as is the case in today's operations). As such, the indicator supports controllers in drawing their mental picture and maintaining their SA. Moreover, according to the EOP survey, most ATCOs agreed that they could easily spot incorrect strip order and manage their strips to get reliable ELZ information during breakoff/missed approach scenarios. From a TWR perspective, controllers strongly agreed (n=2) that they could build sufficient SA to anticipate, in a timely manner, possible deterioration in the required separation/spacing between aircraft and identify all instances of infringement of the required separation/spacing between aircraft. As previously explained, the intention was to collect more quantitative information on situation awareness via EOR questionnaires, but the shortcomings of the SIM rendered this data unreliable. Future phases of development should reassess the ability of human actors impacted by the concept to maintain sufficient levels of situation awareness.	N/A	VLD3-WP2-Hp-RQT-11: The next phase of development shall reassess the ability of human actors impacted by the concept to maintain sufficient levels of situation awareness

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Arg. 2.1: There is an appropriate allocation of tasks between the human and machine (i.e., level of automation).							
Arg. 2.1.1: The task allocation between the human and the machine is consistent with automation principles.							
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.							
VLD3-WP2-HP-10	Issue: The benefit of the tools within this concept is that they process information on behalf of the ATCO and then provides a possible solution. This should therefore enable controllers to use their attentional resources elsewhere, maintain spare capacity to handle unexpected events and switch between tasks more rapidly. However, failure to get the balance right could lead to confusion, loss of confidence, mistrust, and the negation of any benefits.	CLOSED	OBJ-PJ2.01-V3-VALP-HP1.2 OBJ-02.03-V2-VALP-HP2.1.3-001	Real Time Simulation	According to the EOP questionnaire results, majority of controllers (67%, n=6) strongly agreed that the new task allocation between themselves and the automated tools is appropriate. During debriefs, ATCOs also stated that “providing more support for the controller must be a good thing”.	N/A	N/A
Arg. 2.1.3: Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the human actors in a timely, efficient and accurate manner							
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable							
Arg. 2.1.5: Human actors can acquire an adequate mental model of the machine and its automated functions.							
Arg. 2.1.6: The level of trust in automated functions is appropriate.							
Arg. 2.2: The performance of the technical system supports the human in carrying out their task.							
Arg. 2.2.1: The accuracy of information provided by the system is adequate for carrying out the task.							
VLD3-WP2-HP-11	Issue: Information provided by the system has to be sufficiently accurate for ATCOs to be confident that their decisions and plans are correct. Failure to ensure that the system is accurate could lead to human error and potentially a safety or service delivery problem.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.2	Real Time Simulation	According to APP controllers’ feedback during debriefs, the LZ on the radar appeared to be inaccurate (e.g., example given by controller during SIM: “it said 0.3nm when it was more like 0.1nm”). However, this is likely an issue with the simulator and should therefore be investigated. “Most aircraft seemed to pull away from the marker by .5nm once the leader was inside 4DME” (again, this is likely due to inaccuracies of the aircraft speed performance in the simulator).	N/A	VLD3-WP2-Hp-RQT-08: The next phase of development shall check whether perceptions of inaccuracy of the LZ are due to the functionality of the system or due to the design of the SIM

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Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.							
VLD3-WP2-HP-12	Benefit: ATCOS are responsible for resolving infringements. The quicker they can do this the better. Timeliness of information presented by the system to the controllers enables them to be proactive, which increases operational safety.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.2	Real Time Simulation	Generally speaking, 83% (n=6) of APP participants strongly agreed in the EOP questionnaire that the tools adequately support their decision making and their performance of controlling tasks safely and efficiently respectively (67%, n=6). More specifically, most controllers (66.7%, n=6) reported feeling like the ELZ information supported their task performance and was presented at the right time to support decision making. Additionally, TWR controllers felt confident that the system would support them enough in proactively resolving any infringement of the required separation/spacing between aircraft. However, since the RTS was not intended to validate the TWR position, no assessment of information timeliness has been conducted on the TWR side and the previous conclusion was drawn based on perceived rather than experienced situations. Future phases of development should further investigate accuracy and timeliness of information provided to the TWR controller in an RTS.	N/A	VLD3-WP2-Hp-RQT-09: The next phase of development shall fully include the TWR controller position in the design and assessment of the concept
Arg. 2.3: The design of the human-machine interface supports the human in carrying out their tasks.							
Arg. 2.3.1: The type of information provided satisfies the information requirements of the human.							
Arg. 2.3.2: Input devices (e.g., keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]							
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]							
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]							
VLD3-WP2-HP-13	Issue: New alarms and alerts have been developed as part of the concept. Failure to develop that in accordance with HF principles (e.g., NATS Alerting Philosophy, ref) will result in human error/sub optimal performance and possibly safety incidents and reduced service delivery.	OPEN	OBJ-PJ2.01-V3-VALP-HP1.2	Real Time Simulation	Degraded conditions were not simulated in the RTS because the analysis of failure modes is incomplete, which means that alarms and alerts were not assessed. This is to be expected at the stage of concept development. Future phases of development need to include assessments of any actual alarms and alerts included in the concept.	N/A	VLD3-WP2-Hp-RQT-12: The next phase of development shall review the acceptability of any alarms and alerts included in the concept
Arg. 2.3.5: Workstations (e.g., cockpit layout and consoles) adhere to ergonomic principles. [V1: AIR only]							
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]							
VLD3-WP2-HP-14	Issue: According to the Technology Acceptance Model (ref 5), which constitutes a good basis for assessing human actors' trust in a system, two key	OPEN	OBJ-PJ2.01-V3-VALP-HP1.2	Real Time Simulation	While controllers considered most functionalities worked well, adequately supporting them in performing their tasks, 33.4% (n=6) felt that the functionality and the information displayed on the Spacing Status Window	VLD3-WP2-HP-REC-06: The next phase of development should	VLD3-WP2-Hp-RQT-13: The next phase of



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	motivating factors that dictate humans’ willingness to accept and use new tools exist. One of these is the usability of the tools. Failure to ensure that the user interface is usable can lead to controllers rejecting the tools thus negating any benefits that can be realised. It can also lead to human error and therefore introduce a risk to safety and service delivery.				for the INT and FIN is not acceptable, not being salient and intuitive enough (e.g., “it does not grab my attention”, “I don’t feel the way the data moves across is very intuitive”). Although APP controllers mostly strongly agree in the EOP questionnaire (>66.7%, n=6) that the HMI and indicator support are acceptable for all the tested, some feedback was given by the controllers in particular to review the display of the indicator to support aircraft outside of 20 miles from the runway threshold. In addition, with regards to the dependent indicator: “If the dependant indicator line zero information could have had something more relevant than 0.0 it would have been better in my view. 0.0 works fine but it isn't particularly relevant to anything.”. However, there are limitations of what can be displayed on the operational radar display for Heathrow Approach, so little scope for change. A scenario was observed on several occasions where aircraft lost code-callsign conversion causing the aircraft to become uncorrelated (this was caused by an unknown simulator issue). The result being that the tool does not generate an indicator for such aircraft and the ELZ for the following aircraft is suppressed, whereas the Line Zero is not. Some of the controllers did not feel comfortable with this tool behaviour and felt that there was a potential for information the tool displays to cause confusion. They felt that the Line Zero should also be suppressed as there is the potential for this aircraft to be turned early if the Controller does not have full situational awareness of the non-correlated flight. Therefore, it is recommended that this particular behaviour is highlighted in the Controller training and highlighted in the CONOPs. In addition, it should be considered if there are any additional highlights that can be generated on the EFPS system if the event an aircraft becomes uncorrelated to act as an extra attention getter in this scenario. From a TWR perspective, ATCOs felt like they could differentiate between the different types of constraints, as the indicators were sufficiently distinct, thus not raising any usability issues.	review the relevance of the spacing information displayed for dependant aircraft pairs and of the indicator HMI and display for aircraft outside 20 miles from the threshold.	development shall review the salience of the information displayed in the Spacing Status Window VLD3-WP2-Hp-RQT-14: ANSPs should ensure that the tool behaviour in any unusual/edge-case scenarios are highlighted in controller training and in the CONOPs.



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Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]							
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]							
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]							
Arg. 3.1: Effects on team composition are identified.							
Arg. 3.1.1: Changes to existing roles in the team are identified (including roles that become obsolete).							
Arg. 3.1.2: The introduction of new roles to a team is identified.							
Arg. 3.2: The allocation of tasks between human actors supports human performance.							
Arg. 3.2.1: Changes to the task allocation between human actors do not lead to adverse effects on human tasks.							
Arg. 3.2.2: The proposed task allocation between human actors is supported by technical systems/the HMI.							
Arg. 3.2.3: The potential for human error in team tasks is reduced as far as possible.							
Arg. 3.2.4: Team tasks can be achieved in a timely and efficient manner.							
Arg. 3.3: The communication between team members supports human performance.							
Arg. 3.3.1: Intra-team and inter-team communication supports the information requirements of team members.							
Arg. 3.3.2: The phraseology supports communication in all operating conditions.							
Arg. 3.3.3: Changes in communication means & modalities are identified and acceptable.							
Arg. 3.3.4: The communication load of team members is acceptable in normal and abnormal conditions and degraded mode of operations.							
Arg. 3.3.5: Team members can maintain a sufficient level of shared situation awareness.							
Arg. 4.1: The proposed solution is acceptable to affected human actors.							
Arg. 4.1.1: Changes in roles and responsibilities are acceptable to the affected human actors.							
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.							
Arg. 4.2: Changes in competence requirements are analysed.							
Arg. 4.2.1: Knowledge, skill and experience requirements for human actors have been identified.							
VLD3-WP2-HP-15	Issue: Introducing a higher level of automation means that there is normally less work for a controller to carry out. The potential risk this poses is that controllers become de-skilled in these areas. This could lead to human error or an inability for	OPEN	OBJ-02.03-V2-VALP-HP4.2.1-001	Real Time Simulation Subject Matter	Although one APP controller reported in the EOP questionnaire that skill fade as a result of the IA tools' introduction is a possibility ("More reliance on the indicators and less radar judgement if they indicators were to be taken away"), they stated that they are not at all concerned about its potential impact on the safety of operations in	VLD3-WP2-HP-REC-07: SESAR should consider investigating the effectiveness of humans as fallbacks	VLD3-WP2-Hp-RQT-05: The next phase of development shall assess the



Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
	humans to act as a fallback to system failures, which could introduce a risk to operational safety.			Expert Discussion	the case of the IA tools. However, the risk of human deskilling as a result of automated tools introduction is a general issue encountered in most system changes and requires investigation at a higher level. Additionally, concerns about controllers having trained only on PWS being subjected to edge cases were raised during debriefs and, although the RTS was basically run under degraded conditions as a result of the system failure, no proper fallback scenario was tested during this validation iteration. As such, the next phase of development should assess the extent to which controllers can safely perform in fallback scenarios, as a starting basis for understanding how ATCOs only trained on PWS and deskilled ATCOs may perform in degraded system operations.	when technology systems fail	extent to which controllers can follow degraded mode operating methods, including fallback
VLD3-WP2-HP-16	Issue: The rate and scale of change that and ATCO experiences can affect their ability to perform their jobs safely and effectively. The scale of change associated with this concept is very large for some. Failure to provide in-depth training that delivers the appropriate confidence and competence levels could lead to human error, which could introduce a risk to operational safety.	OPEN	OBJ-02.03-V2-VALP-HP4.2.1-001	Real Time Simulation	During RTS debriefs, controllers stated that they feel the introduction of the IA tools as a replacement of the current eTBS setup is a very big shift (with the biggest change in HMI). According to them, the shift is bigger than the one they experienced when switching from TBS to eTBS, feeling more like the initial switch from DBS to TBS, and it will require in-depth training to ensure the safety of operations.	N/A	VLD3-WP2-Hp-RQT-15: ANSPs shall design and develop appropriate training solutions to successfully implement the concept

Arg. 4.2.2: The impact on operator licensing (as defined by the regulating bodies) has been identified.

Arg. 4.2.3: Potential interferences between existing and new knowledge & skills are identified.

Arg. 4.3: Changes in staffing requirements and staffing levels are identified.

Arg. 4.3.1: The impact on staff levels is identified.

Arg. 4.3.2: The impact on shift organisation is identified.

Table 9: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

4.4.2 Maturity of the Solution

Maturity checklist for finalising the DEMOR assessment			
ID	Question	Answer	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes - OK	See section 4.4.1 of this report
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e., on the level required for V3)?	Partially OK – No Blockers	See section 4.2.1 and 4.4.1
3	Have all the parts of the solution/concept been considered?	Yes - OK	See DEMOR Part 1
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes - OK	See DEMOR Part 1
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Partially OK – No Blockers	Several recommendations and requirements have been created (see section 4.4.1 and Appendices B and C). Fulfilment of them should provide the evidence needed to conclusively determine that the solution is consistent with human capabilities.
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Partially OK – No Blockers	Several recommendations and requirements have been created (see section 4.4.1 and Appendices B and C). Fulfilment of them should provide the evidence needed to conclusively determine that the results are in line with targets.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	NOK	Degraded conditions were not able to be tested. Furthermore, there were several limitations to the performance of the RTS that reduced its realism; for example, the flight progress strip display system was faulty. See section 4.3.1 of this report for more details.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Partially OK – No Blockers	Several recommendations and requirements have been created (see section 4.4.1 and Appendices B and C). Fulfilment of them should provide the evidence needed to conclusively determine that the interactions between human and technology are operationally feasible.

9	Has all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Achieved	Compare the HP table in section 4.4.1 to the DEMOR pts 1 and 5.
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Partially OK – No Blockers	Several recommendations and requirements have been created (see section 4.4.1 and Appendices B and C). Fulfilment of them should provide the evidence needed to conclusively determine that all 16 issue/benefits have been satisfied.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation, and training?	Achieved	Several recommendations and requirements have been created (see section 4.4.1 and Appendices B and C).
12	Have the major factors that can influence the transition feasibility (e.g., changes in competence requirements, recruitment, and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	Achieved	A couple of recommendations and requirements relating to transition factors have been included (see section 4.4.1 and Appendices B and C)
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	Achieved	It is not expected that regulations will need to change as a result of this concept.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Achieved	Several recommendations and requirements regarding the design of the HP assessment in the next phase of development have been created.

Table 10: Solution Maturity Table

5 References

Human Performance

- [1] SESAR (2020). SESAR Human Performance Assessment Process V1 to V3 – including VLD, ed. 00.03.01
- [2] D1.4 VLD3-W2-SORT-WP2 Demonstration Plan (DEMOP) – Part IV: Human Performance Assessment Plan.
- [3] D1.4 VLD3-W2-SORT-WP2 Demonstration Report (DEMOR) – Part I
- [4] D1.4 VLD3-W2-SORT-WP2 Demonstration Plan (DEMOP) – Part I
- [5] [Venkatesh & Davis \(2000\). A Theoretical Extension of the Technology Acceptance Model.](#)

Appendix A – Additional HP activities conducted

There were no additional HP activities conducted.

Appendix B – HP Recommendations Register

HP Recommendations Register									
Reference	Type of recommendation	Recommendation	Rationale	Assessment source + Reference report	Scope (Air, Air/Ground, Ground)	Concept/solution Involved	Recommendation status	Rationale in case of rejection	Comments
VLD3-WP2-HP-REC-01	NEW OBJECTIVE	The next phase of development should consider the potential benefit of writing a procedure that enables FIN to use vertical separation if considered appropriate	See Issue VLD3-WP2-HP-02 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-REC-02	NEW OBJECTIVE	ANSPs should ensure that the tool behaviour in any unusual/edge-case scenarios are highlighted in controller training and in the CONOPs	See Issue VLD3-WP2-HP-03 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

VLD3-WP2-HP-REC-03	NEW OBJECTIVE	The next phase of development should further investigate the validity of the perception that the HMI design of the tools and the operating techniques/procedures associated with the tools increase controllers' workload and whether than increase is acceptable (i.e. falls within the normal variability of workload levels)	See Issue VLD3-WP2-HP-07 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-REC-04	NEW OBJECTIVE	The next phase of development should assess the validity of the perception that more than 0.5nm would be safer for breakthrough	See Issue VLD3-WP2-HP-08 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-REC-05	NEW OBJECTIVE	The next phase of development should also collect HP data from ATCOs without previous knowledge of	See Issue VLD3-WP2-HP-08 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

		or interaction with the concept tools		Subject Matter Expert Discussion					
VLD3-WP2-HP-REC-06	NEW OBJECTIVE	The next phase of development should review the relevance of the spacing information displayed for dependant aircraft pairs and of the indicator HMI and display for aircraft outside 20 miles from the threshold	See Issue VLD3-WP2-HP-14 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-REC-07	NEW OBJECTIVE	SESAR should consider investigating the effectiveness of humans as fallbacks when technology systems fail	See Issue VLD3-WP2-HP-15 in Table 9	Real Time Simulation (see section 4.4.1) Subject Matter Expert Discussion	Air	SORT	TBC	TBC	N/A

Table 11: HP Recommendations

Appendix C – HP Requirements Register

HP Requirements Register									
Reference	Type of requirement	Requirement	Rationale	Assessment source + Reference report if available	Scope (Air, Air/Ground, Ground)	Concept/solution Involved	Requirement status	Rationale in case of rejection	Comments
VLD3-WP2-HP-RQT-01	NEW OBJECTIVE	The next phase of development shall define the GS's responsibilities with regards to this concept	See Issue VLD3-WP2-HP-01 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-02	NEW OBJECTIVE	ANSPs shall include GSs in any training solutions regarding this concept	See Issue VLD3-WP2-HP-01 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

VLD3-WP2-HP-RQT-03	NEW OBJECTIVE	Indicator HMI and procedures should be designed as such that there is no increased risk in loss of separation	See Issue VLD3-WP2-HP-02 and Issue VLD3-WP2-HP-06 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-04	NEW OBJECTIVE	The next phase of development shall design an activity to assess the extent to which operating methods cover degraded modes of the ATM system	See Issue VLD3-WP2-HP-04 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-05	NEW OBJECTIVE	The next phase of development shall assess the extent to which	See Issue VLD3-WP2-HP-05 and Issue VLD3-	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

		controllers can follow degraded mode operating methods, including fallback	WP2-HP-15 in Table 9						
VLD3-WP2-HP-RQT-06	NEW OBJECTIVE	The next phase of development shall reassess the acceptability of controllers' workload	See Issue VLD3-WP2-HP-07 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-07	NEW OBJECTIVE	The next phase of development should better understand the mediating and moderating effects of controller attitudes on intention to use the	See Issue VLD3-WP2-HP-08 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

		concept as designed							
VLD3-WP2-HP-RQT-08	NEW OBJECTIVE	The next phase of development shall check whether perceptions of inaccuracy of the LZ are due to the functionality of the system or due to the design of the SIM	See Issue VLD3-WP2-HP-08 and Issue VLD3-WP2-HP-11 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-09	NEW OBJECTIVE	The next phase of development shall fully include the TWR controller position in the design and assessment of the concept	See Issue VLD3-WP2-HP-08 and Issue VLD3-WP2-HP-12 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

VLD3- WP2-HP- RQT-10	NEW OBJECTIVE	If the system is overly pessimistic, the next phase of development should assess the extent to which controllers' decisions are influenced by prevalence and/or expectation bias	See Issue VLD3-WP2-HP-08 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3- WP2-HP- RQT-11	NEW OBJECTIVE	The next phase of development shall reassess the ability of human actors impacted by the concept to maintain sufficient levels of situation awareness	See Issue VLD3-WP2-HP-09 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

VLD3-WP2-HP-RQT-12	NEW OBJECTIVE	The next phase of development shall review the acceptability of any alarms and alerts included in the concept	See Issue VLD3-WP2-HP-13 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-13	NEW OBJECTIVE	The next phase of development shall review the salience of the information displayed in the Spacing Status Window	See Issue VLD3-WP2-HP-14 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A
VLD3-WP2-HP-RQT-14	NEW OBJECTIVE	ANSPs should ensure that the tool behaviour in any unusual/edge-case scenarios are	See Issue VLD3-WP2-HP-14 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

		highlighted in controller training and in the CONOPs							
VLD3-WP2-HP-RQT-15	NEW OBJECTIVE	ANSPs shall design and develop appropriate training solutions to successfully implement the concept	See Issue VLD3-WP2-HP-16 in Table 9	Real Time Simulation (see section 4.4.1)	Air	SORT	TBC	TBC	N/A

Table 12: HP Requirements

Appendix D – HP Log

For WP02 of the SORT solution, it was decided that an HP Log would not be created.

-END OF DOCUMENT-