VERY LARGE SCALE DEMONSTRATION

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PJ37-W3-ITARO

INTEGRATED TMA, AIRPORT AND RUNWAY OPERATIONS

This Human Performance Assessment Report is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 101017622 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document contains the Human Performance Assessment Report (HPAR) for the ITARO Departures solution track (PJ.37-W3-01B). It consists of the Human Performance Assessment Plan (HPAP), the results of the Human Performance (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 (maturity level).

PJ.37-W3-01B focuses on the results from the Real Time Simulation (RTS), held at Heathrow Airport Tower simulators in September 2022, concerning the Human Performance objectives as described in the HPAP ([2]).

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1 Executive Summary

This Human Performance Assessment Report (HPAR) summarises the results of the completed HF (Human Factors) activities for ITARO Departures solution track PJ.37-W3-01B completed in accordance with those set out in the Human Performance Assessment Plan (HPAP). The Real Time Simulation (RTS) demonstration (DEMO) was executed at Heathrow Airport Tower Simulators, with the Terminal Access Controller (TAC) (Air and Ground), and the Aircraft Control Position Operators (ACPOs) based at NATS Corporate & Technical Centre (CTC), Southampton. Only the Air position was measured during this exercise. The overall aim of the RTS was to extend the Optimised Separation Delivery (OSD) tool in order to:

- Support the reduction and refinement of non-wake departure route separations to achieve a target distance spacing prior to handover to the Terminal Manoeuvring Area (TMA) controller.
- Receive a feed of data from the TMA in order that optimised departure separations do not put an excessive demand onto TMA sectors.

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

- Arg 1: The role of the human is consistent with human capabilities and limitations.
- Arg 2: Technical systems support the human actors in performing their tasks.
- Arg 3: Team structures and team communication support the human actors in performing their tasks.
- Arg 4: Human Performance related transition factors are considered.

Evidence was gathered using both qualitative and quantitative methods. This included questionnaires at End of Run (EOR) and End of Simulation (EOS). A post-validation expert workshop was also used to present the results and gather further feedback from the controllers.

For Workload (WL), the results showed acceptable WL levels with most of the participants indicating “negligible” workload as a result of the extended OSD tool. For Situation Awareness (SA), results also showed acceptable SA levels with most of the participants indicating “Very Good” SA. The feedback from the Air Traffic Controllers also suggested that participants could follow the operating methods without significant WL increase or SA issues, as they did not consider that the risk is any greater with the extended OSD tool in the case of non-nominal scenarios.

However, ATCOs expressed a preference for additional support, e.g., a fallback matrix for degraded/failure modes. ATCO feedback suggests that the extended OSD tool can be highly beneficial, especially in a flow restriction and departure-heavy period, but system failure in such a situation could be problematic.

ATCOs felt like they could perform their tasks in a timely, efficient and accurate manner. They also agreed that the extended OSD tool supports them in creating an accurate mental model, which aids them in decision making and future state forecasting of separating aircraft. However, support from a type of Departure Manager (DMAN) would be useful: “having the knowledge about the departure sequence would be helpful and less distracting”. While several participants found the Human-Machine Interface (HMI) design reasonable and usable on Airport Display Information System (ADIS), some suggestions were put forth for the location of the timer.

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For the next phase of the project, it is recommended that an HMI Development workshop is conducted to gather further feedback from the users.

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2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the ITARO solution track (PJ.37-W3-01B) results of Real Time Simulation (RTS) EXE-PJ.37-W3-004 concerning the Human Performance objectives as described in the Human Performance Assessment Plan (D1.4-PJ37-W3-ITARO, DEMOP – Part IV – Human Performance Plan). It also aims to present the HP activities completed to address the HP arguments relevant for PJ.37-W3-01B, capturing the specific HP issues and benefits.

The intended audience for this document are the other team members of the PJ.37-W3-ITARO DEMO under investigation. HP practitioners at the level of the transversal areas are also expected to have an interest in this document. Other stakeholders that may be interested in this document are to be found among:

- SESAR PJ.37-W3-ITARO partners.
- SESAR3 Joint Undertaking (S3JU)
- SESAR PJ.01-W2-EAD partners
- Air Navigation Service Providers (including Air Traffic Controllers).
- Airport owners / providers.
- Airline operators (including flight crew) and other airspace users.

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2.2 Structure of the document

This document is Part III of the DEMOR. It describes the expected changes within the defined HP arguments, identified issues and benefits and the derived HP objectives and HP activities that need to be considered within the validation exercises.

The document consists of six chapters:

- **Chapter 1: Executive Summary.** Provides a summary of the key information and elements contained in the Human Performance Assessment Report.
- **Chapter 2: Introduction.** Provides the document purpose and structure, intended readership and the background activities to be considered.
- **Chapter 3: The Human Performance Assessment Process: Objective and Approach.** Provides the general background for the Human Performance Assessment process.
- **Chapter 4: Human Performance Assessment.** Provides a brief description of the overall aim of the Human Performance Assessment Plan and provides the list of the different technical validation exercises.
- **Chapter 5: References**. Lists all references and applicable documents that have been considered in the production of the HPAP.
- **Chapter 6**: **Appendices.** Contains an overview of the complete HP requirement register

2.3 Acronyms and Terminology

Term	Description
Extended OSD tool (eOSD)	Extended version of the Optimised Separation Delivery tool developed in PJ.02-01-02 to provide support to the Tower Runway Controller for the application of refined, more granular route spacings on departure, as well as wake turbulence separations.
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 *focussing on the variables that determine Human Performance*.
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 focussing on the observable result of human activity in a work context*. 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.

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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.
Pairwise	Procedure designed for use between arrivals on final approach or between departures from the runway, based on an optimum adjusting of the needed separation between two aircraft taking into account their respective characteristics and giving Controllers more dynamic separation options.
RECAT-EU	RECAT-EU is a 6 category wake scheme aims to provide a more efficient WT scheme by re-grouping aircraft based upon MTOW and wingspan and is the result of an optimization of the ICAO wake turbulence separation classes.

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TBS	Refers to the generic TBS concept that was developed in SESAR 1 Project P06.08.01 which included tool support to show the Controller the required separation.
WDS	Weather Dependent Separation

Table 1: Acronyms and Terminology

Acronyms	
ABES	Abnormal and Emergency Situation Training
ACPO	Aircraft Control Position Operator
ADIS	Airport Display Information System
AIM	Accident/Incident Model
ASMGCS	Air Surface Movement Ground Control Surveillance
ATCO	Air Traffic Controller/Air Traffic Control Officer
ATM	Air Traffic Management
CDM	Clearance Delivery Manager
CWP	Controller Working Position
DEMO	Demonstration
DMAN	Departure Manager
EFPS	Electronic Flight Progress System
EOR	End of Run
EOS	End of Simulation
Extended OSD	Extended Optimised Separation Delivery
FDE	Flight Data Editor
GND	Ground Controller
HMI	Human Machine Interface
HPAP	Human Performance Assessment Plan
KPA	Key Performance Area
LHR	London Heathrow Airport
MAC AIM	Mid-Air Collision AIM
MRS	Minimum Radar Separation
RTS	Real-Time Simulation
RWY	Runway
SA	Situation Awareness
SESAR	Single European Sky ATM Research Programme
SME	Subject Matter Expert
SPR-INTEROP	Safety and Performance Requirements – Interoperability Requirements / Operational Service and Environment Definition
TAC	Terminal Access Controller
TATC	Trainee Air Traffic Controller
TC	Terminal Control

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TMA	Terminal Manoeuvring Area
TWR	Tower
UI	User Interface
WL	Workload
WTE AIM	Wake Turbulence Encounter AIM

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3 The Human Performance Assessment Process: Objective and Approach

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. Reference [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 (see Appendix A) 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. This HP Log is a living document and is continuously updated and / or added to as the SESAR DEMO progresses.

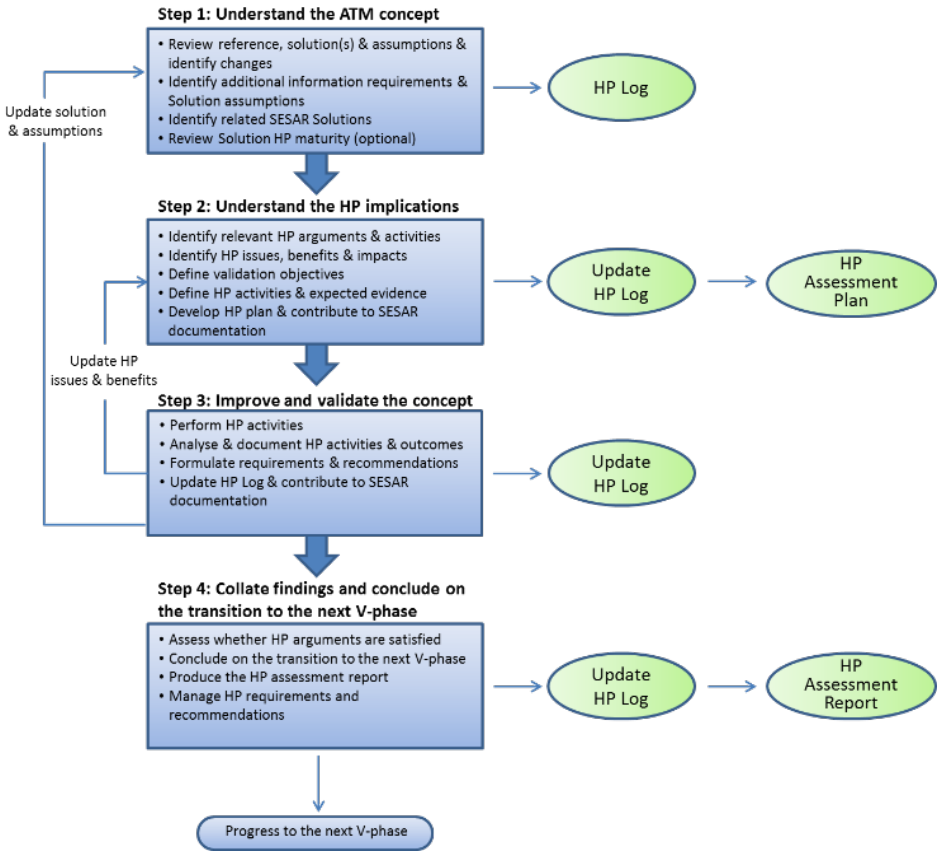

Figure 1: Steps of the HP Assessment Process

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4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

The environment that NATS is using to develop and validate the proposed solution is London Heathrow Airport (EGLL). London Heathrow is one of the busiest airports in the world, handling approximately 80.9 million passengers in 2019. Figure 2 shows that there are two east-west parallel runways.

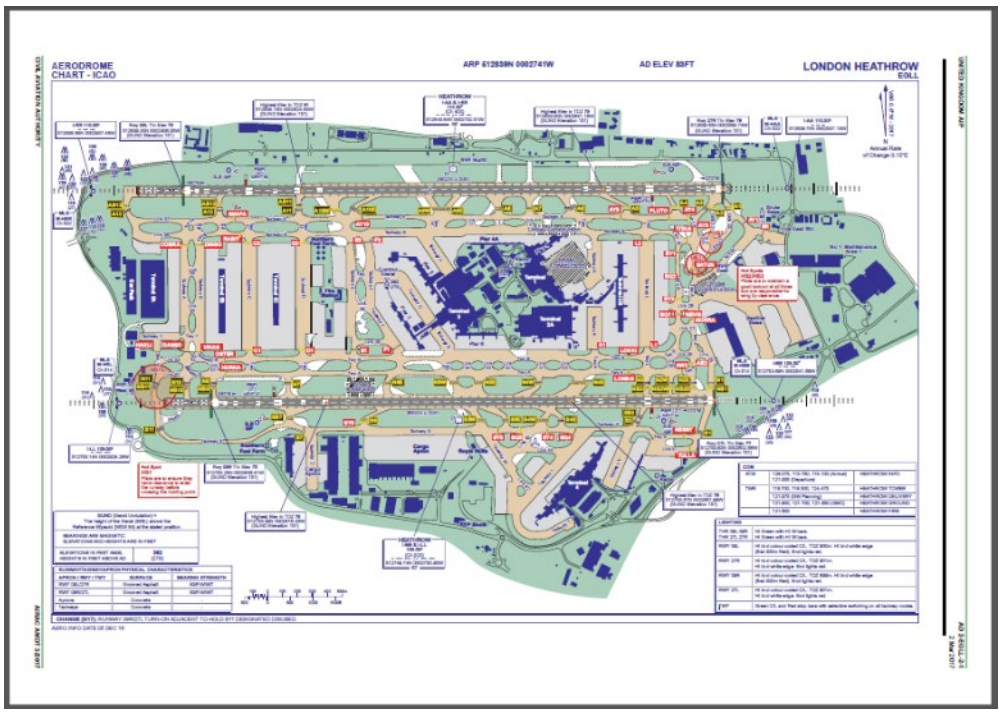

Figure 2: London Heathrow Aerodrome Chart

A number of different modes of operation are in use at Heathrow. For the purposes of PJ.37-W3 01B, only operations in segregated mode have been assessed. Segregated parallel operations are where one runway is used for approaches and landings and one runway is used for departures. On easterlies, arrivals are generally on 09 Left (09L) and departures on 09 Right (09R). On westerlies, a Runway Alternation programme, where the landing and departure runways are swapped halfway through the day, exists in order to provide predictable periods of noise relief for local communities. Given that the concept will apply to the departure runway only, each of the possible configurations should ideally be considered as part of the HP and Safety assessment. It should be noted that during the RTS activity only 27R and 09R were assessed (see section 4.4.1 for details).

4.1.2 Description of DEMO/Reference Scenario

A detailed description of the DEMO/Reference Scenario is contained in the DEMO Plan Part 1 (Section 5.3.4).

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In summary, the overall aim of the DEMO is to extend the Optimised Separation Delivery (OSD) tool developed in SESAR 2020 Wave 1 PJ.02-01-02 in order to:

- Support the reduction and refinement of departure route separations to achieve a target distance spacing prior to handover to the Terminal Manoeuvring Area (TMA) controller.
- Receive a feed of data from the TMA in order that optimised departure separations do not put an excessive demand onto TMA sectors.

4.1.3 Consolidated list of assumptions

A consolidated list of assumptions is contained within the "Solution & Concept Info" tab of the HP Log (Appendix A). The list refers to the specific part of the HP Log which generated the assumption. A cross-reference is also provided in the body of the HP Log to help locate the assumption.

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

A consolidated list of related SESAR solutions is contained within the "Solution & Concept Info" tab of the HP Log (Appendix A). Details are also contained in Section 2.4.2 of the DEMOP Part 1.

4.1.5 Identification of the nature of the change

A Scoping & Change Assessment workshop was held on 14th July 2021 to systematically identify and capture the nature of the change that may result due to the introduction of the concept under investigation. Following this workshop, a further review by the HP Lead of the relevant SESAR documentation was conducted. The results of these activities are recorded in the "Change & Argument Identification" tab of the HP Log (Appendix A).

In summary, all four high level HP Arguments are impacted in some way by the options being developed by solution track PJ.37-W3-01B. These are:

- Arg 1: The role of the human is consistent with human capabilities and limitations.
- Arg 2: Technical systems support the human actors in performing their tasks.
- Arg 3: Team structures and team communication support the human actors in performing their tasks.
- Arg 4: Human performance related transition factors are considered.

4.2 Step 2 Understand the HP implications

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

Details regarding the relevant arguments, their associated issues and benefits and the HP activities that are planned to investigate them are contained within the "Issue-Objective-Outcome" tab of the HP Log (Appendix A).

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4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

The following tables provide detailed descriptions of the HP activities conducted.

HP activity	Conducted
Risk & Benefit Analysis	End July 2021
Human Centred Design Workshop	End of July 2021
Real Time Simulation (RTS)	September 2022
Post-simulation ATCO Workshop	October 2022

Table 2: Table of HP Activities

Activity 1.	Risk & Benefit Analysis
Description	Focus groups to assess the credibility of the issues and benefits identified in the HP log, add additional issues and benefits if required and identify potential mitigations to reduce the risk of human error introduced by the solutions.
HP OBJECTIVES	See HP Log
Tool selected out of the HP repository	AIM Models
Planning and Approach	Using a range of tools (e.g., bowtie, barrier models, etc.) a list of credible human-error related safety and service delivery risks and benefits has been produced. A plan for managing these risks and benefits has been produced.
Timeline	July 2021

Table 3: Description of Activity 1

Activity 2	Human Centred Design Workshop
Description	A workshop to design the extended OSD tool Human-Machine Interface with end users.
HP objectives	See HP Log.
Tool selected out of the HP repository	CoRe Baseline Style Guide; ISO 9241: Ergonomics of Human-System Interaction; Guidelines for the Use of Colour in ATC Displays.

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Planning and Approach	Using a range of HP-related international standards and guidance, the design of the extended OSD tool has been reviewed and recommendations made to further optimise its design.
Timeline	July 2021

Table 4: Description of Activity 2

Activity 3	Real Time Simulation Assessments
Description	Assessment of whether the extended OSD concept being developed by PJ.37-W3-01B meets relevant HP Arguments.
HP objectives	See HP Log
Tool selected out of the HP repository	SHAPE metrics[1]
Planning and Approach	Using a range of quantitative and qualitative metrics, evidence was gathered from users on the validity of the extended OSD tool from an HP perspective.
Timeline	September 2022

Table 5: Description of Activity 3

Activity 4	Post-simulation ATCO Workshop
Description	Further assessment of whether the extended OSD concept being developed by PJ.37-W3-01B meets relevant HP Arguments, by gaining additional feedback from controllers.
HP objectives	See HP Log
Tool selected out of the HP repository	SME discussions
Planning and Approach	Based on the Real Time Simulation findings, additional evidence was gathered from users on the validity of the extended OSD tool from an HP perspective. Issues not addressed during the RTS were covered and any further issues/benefits emerging from the RTS were discussed.
Timeline	October 2022

[1] SHAPE questionnaires were developed by Eurocontrol to assess the effect of ATM system components on human performance.

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Table 6: Description of Activity 4

Figure 3 shows the layout of the Heathrow Tower simulation facility. The figure gives an impression of the controller working position as was used in the RTS.

Figure 3: Heathrow Simulation Facility

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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
ROLES & RESPONSIBILITIES							
Roles and responsibilities of human actors are clear and exhaustive							
Arg. 1.1.2: The description of roles & responsibilities covers all tasks to be performed by a human actor.							
ID1.1.2-1	**Issue:** The need for information to be fed into the extended OSD tool from the TMA will be built into the concept and therefore the right human actor to whom the task can be allocated needs to be identified. Failure to do so could lead to confusion and sub-optimal performance. Note: This is an automatic task (electronic data-feed), therefore not assigned to a human actor. However, the Air Deps Controller uses the output from the TMA data-feed, which is displayed on their HMI.	OPEN	OBJ-37.1b-eOSD-01	Stakeholder Workshop Real Time Simulation: An emulated TMA data feed was incorporated into the concept RTS. A Reference Scenario was run, as well as two different Solution Scenarios: TMA data-feed and no TMA data-feed Post-RTS questionnaires	The tasks and responsibilities of each human actor were analysed and are defined in the Change & Argument Identification tab of the HP Log. During the Stakeholder Workshop, ATCOs stated that the TMA data feed offered better support in carrying out their tasks as opposed to no TMA data-feed or the Reference Scenario. Analysis of post-sim HP questionnaire data indicates an increase in “Very good” situational awareness entries and a decrease in the “High/Very High” workload levels in the case of the TMA data-feed provision scenario as opposed to the Reference Scenario and the no TMA data-feed. Therefore, it appears that inclusion of the TMA traffic levels into the extended OSD tool best supports human performance. Additionally, the impact on the TMA should be studied. A safety discussion was carried out with a TMA controller, during which aspects such as WL increase and TMA traffic overload were highlighted, but further consideration should be given to this in the next project stage.	REC-37-W3-DEMOR-HP-01: Further study the impact of the extended OSD solution deployment on the TMA by means of RTS	N/A
Operating methods are exhaustive and support human performance							
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.							
ID 1.2.1-1	**Issue:** It is not currently clear if minimum radar separation (MRS) can be assured if the leader is a/b on the ATM and the follower is a/b on ASMGCS**.** Failure to clarify this procedure could reduce how much the risk that ATCOs overcompensate for inaccuracies in the extended OSD and manually under-separate a/c can be mitigated.	CLOSE	OBJ-37.1b-eOSD-02	Discussions with SMEs	Discussions with SMEs concluded that this issue is also present in today’s operations and would not pose any additional risks/threats with the deployment of the extended OSD tool.	N/A	N/A
Arg. 1.2.3: Operating methods cover degraded modes of the ATM system.							
ID 1.2.3-1	**Issue:** Data used by the extended OSD tool could be incorrect or presented incorrectly to the ATCO. However, this could go unnoticed by the ATCO because the output from the tool remains credible. **Failure to address this issue could cause controllers to give a premature take-off clearance with respect to SID spacing which could lead to a loss of MRS in LHR/TMA airspace (MAC AIM; WTE AIM). It could also increase the cognitive demand and physical tasks to be undertaken by controllers to such an**	OPEN	OBJ-37.1b-eOSD-03	Stakeholder Workshop	Currently, the considered degraded operation modes are the TMA data feed unavailable and credibly corrupt data (the latter one has not been addressed). The standard fallback procedure for failure of the route count down timer and degraded modes was defined and implies switching back to controllers using manual calculations in the same way they are currently doing. During the stakeholder workshop, participants did not consider that the safety risk is any greater with the extended OSD tool in the case of non-nominal scenarios but expressed the importance of clear	REC-37-W3-DEMOR-HP-02: Assess the credibility of the corrupt data scenario and, if necessary, run RTS for this scenario	N/A

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	extent that the TWR and/or TC ATCOs are working at the limit of their workload capacity.				indications in the case of system failure and considered some form of fallback matrix should be introduced to support operations in degraded/failure modes. The potential difficulty of the mode transition was also highlighted: participants stated that while the tool unlocks new features, trying to quickly start up the fallback process may prove challenging and could be impacted by skill fade. Nonetheless, ATCOs stated that with regular training on manual operations that would not represent a major issue, as the tool does not entirely deskill them, and they feel like they are still in the operational loop, required to make judgements and not entirely rely on the extended OSD tool for issuing clearances. SMEs also emphasised that credibly corrupt data could be a critical issue, as both the experienced and inexperienced ATCOs would have difficulty in realising that something is wrong (the issue would be more prominent for inexperienced ATCOs). Failure to address the credibly corrupt data scenario could have a serious negative impact on the safety of operations, as controllers could give a premature take-off clearance or end up working at the limit of their workload capacity after identifying the issue.		
Arg. 1.2.5: Operating methods can be followed in an accurate, efficient and timely manner.							
ID 1.2.5-1	**Issue:** The extended OSD tool fails at a point which negatively impacts a controllers' ability to decide when to issue a take-off clearance. The current concept states that in a degraded mode (e.g., credibly corrupt data) the procedure would be to revert to applying procedural separations. **The ability of controllers to successfully complete this fallback procedure needs to be tested otherwise they may give a premature take-off clearance with respect to the SID spacing which could lead to a loss of MRS in LHR/TMA airspace (MAC AIM; WTE AIM). It could also increase the cognitive demand and physical tasks to be undertaken by controllers to such an extent that the TWR and/or TC ATCOs are working at the limit of their workload capacity.**	OPEN	OBJ-37.1b-eOSD-04 OBJ-37-W3-DEMOP-HUP1-0017	Real Time Simulation: various scenarios were run for normal, abnormal and tool failure scenarios ('DELETE' failure case, where the Tool provides no support for a period - 5 minutes -, 'TMA data-feed fails to send departure flow restriction to the extended OSD tool for next departing aircraft). No scenario was run for the credibly corrupt data situation Stakeholder Workshop Post-RTS questionnaires	ATCOs could follow the operating methods without significant WL increase or SA issues, even in failure and degraded mode cases for the route count down timer. However, they expressed a preference for additional support, e.g., a fallback matrix for failure modes. Potential issue in applying operating methods for 'inter' wake [Pairwise] categories were quoted: "I only looked at the countdown timer when I believed a wake separation was required. This works in a RECAT-EU scenario but if there were 'inter' wake [Pairwise][2] category separations I am not sure I would have realised". Questionnaire feedback indicated that participants tended to ignore the tool during an 'event'.	REC-37-W3-DEMOR-HP-02: Run RTS with the credibly corrupt data scenario and assess how well the operating methods can be followed. REC-37-W3-DEMOR-HP-03: When assessing the relative benefit delivered by the tool, the frequency of "inter-wake" [Pairwise] category flights should be calculated and included in the description of the operating environment.	N/A
Human actors can achieve their tasks (in normal and 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.							

[2] It should be noted that though the controller referred to "inter-wake" categories, further clarification was sought and they meant Pairwise separation categories.

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ID 1.3.1-1	**Issue:** A poorly designed concept solution will introduce human error into the system for any/all human actors. **Failure to identify and effectively mitigate potential human performance and human error related risks may increase the risk to safety and service delivery.**	CLOSED	OBJ-37.1b-eOSD-04 OBJ-37-W3-DEMOP-HUP1-0018	Stakeholder Workshop Real Time Simulation	During the stakeholder workshop, ATCOs stated they felt like the extended OSD tool supported them in better completing their tasks and that training and experience with the tool would significantly decrease any potential human performance and human error related risks.	N/A	N/A
Arg. 1.3.2: Tasks can be achieved in a timely manner.							
ID 1.3.2-1	**Benefit:** The concept solution provides additional information regarding the SID spacing requirements between two non-wake pairs. This may enable RWY controllers to make quicker decisions about what instructions to give and when to give them to the aircraft on their frequency. It may also impact the speed of the decisions made by GND controllers and CDMs. This may create the necessary reduction in cognitive workload to reallocate resources to handling more aircraft (i.e., operational capacity/throughout may increase). The projected benefit that can be achieved if ATC/Flight crew are trainees or new validated may be reduced or negated as they work more slowly and expend a greater amount of cognitive effort when performing tasks.	CLOSE	OBJ-37.1b-eOSD-06 OBJ-37-W3-DEMOP-HUP1-0019	Real Time Simulation Stakeholder Workshop: user feedback on task performance Post-RTS questionnaires	The post-RTS questionnaire data analysis showed that all entries agreed (30.5%) and strongly agreed (69.5%) that controlling tasks can be achieved in a timely manner. During the stakeholder workshop, ATCOs stated that they do not feel like the decrease of spacings would impact other tasks or their timeliness and that they could perform their tasks effectively. Additionally, they consider that not having to work out the time and instead following the timer would generate a taskload decrease leading to a reduction in cognitive workload. As such, they felt they could reallocate resources to other relevant activities.	N/A	N/A
ID 1.3.2-2	**Issue:** the aim of the concept solution is to improve runway throughput by reducing spacings between two non-wake pairs of departing aircraft. This may impact controllers overall task performance as they often have several tasks to complete within a short period of time and therefore need to be able to effectively manage the speed with which they swap between these tasks and the accuracy of their performance on each.	OPEN	OBJ-37.1b-eOSD-07 OBJ-37-W3-DEMOP-HUP1-0008	Real Time Simulation Stakeholder Workshop: user feedback on task performance Post-RTS questionnaires	No outstanding issues were identified with respect to task completion timeliness, as described in Arg. 1.3.2. However, during the Stakeholder Workshop ATCOs highlighted that being supported by a type of departure manager (DMAN) would be useful, as tasks could be achieved more efficiently in a timelier manner by knowing departure information in advance: “having the knowledge about departure sequence would be helpful and less distracting”.	REC-37-W3-DEMOR-HP-04: Assess benefit credibility of DMAN support, run RTS with DMAN support	N/A
Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.							
ID 1.3.3-1	**Benefit:** The concept solution automates the calculation of the SID Separation value to be applied between a non-wake pair of a/c. This may enable RWY controllers to make quicker decisions about what instructions to give and when to give them to the aircraft on their frequency. It may also impact the speed of the decisions made by GND controllers and CDMs. This may create the necessary reduction in cognitive workload to reallocate resources to handling more aircraft (i.e., operational capacity/throughout may increase) The projected benefit that can be achieved if ATC/Flight crew are trainees or new validated may be reduced or negated as they work more slowly and expend a greater amount of cognitive effort when performing tasks.	CLOSE	OBJ-37.1b-eOSD-08 OBJ-37-W3-DEMOP-HUP1-0020	Real Time Simulation Post-RTS questionnaires User feedback on workload during Stakeholder Workshop	Most entries (44.1%) indicated moderate average WL levels and moderate-high peak WL levels (47.1%). Participants stated that workload was more manageable thanks to support given by MDI restriction on the tool and the workload level was overall more manageable with the tool. The TMA data feed scenario yielded the best results, pointing to a shift towards the lower end of the WL scale as opposed to Reference Scenario and no TMA feed. Additionally, they consider that not having to work out the time and instead following the timer would generate a taskload decrease that would even allow them to have the mental capacity/availability to do something else. Lastly, participants felt using the tool would decrease WL during the hours of darkness (when operations would imply using the lighting screen – not tested in the RTS), as opposed to current operations.	N/A	N/A

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ID 1.3.3-2	**Issue:** the concept solution is designed to increase runway throughput. A credible hazard was identified that controllers may give premature take off clearances leading to an overload (i.e., controller reaches their limit of mental and physical capacity). **This may increase the risk of further human errors/safety incidents occurring or impact service delivery goals.**	OPEN	OBJ-37.1b-eOSD-09 OBJ-37-W3-DEMOP-HUP1-0009	Real Time Simulation Post-RTS questionnaires User feedback on workload during Stakeholder Workshop	During the stakeholder workshop, the ATCOs acknowledged that in failure modes an immediate spike in workload could ensue, which normally would then flatten, with no significantly greater impact than today's operations. Participants pointed out that the extended OSD tool can be highly beneficial especially in a flow restriction and departure heavy period, but that system failure in such a situation could be problematic. As such, they agreed that the business of operations, level of ATCO experience and the fallback matrix would play a defining role in the flattening of that curve. Having a very restrictive fallback matrix to follow during failure mode could work, but it would be difficult to follow during very busy times and it would increase workload. The impact of potential skill fade on manual operations fallback was also raised. Controllers expressed a preference for having a clear indication regarding the nature of the displayed time (whether it relates to a route separation or flow restriction), as not having the difference clearly expressed could lead to a workload increase. A negligible increase in WL due to communication and coordination aspects with the ground controller was quoted.	REC-37-W3-DEMOR-HP-05: Investigate the cause-effect relationship between communication and workload REC-37-W3-DEMOR-HP-06: Further development of a fallback matrix should take place, in order to ensure all workload issues are identified	REQ-37-W3-HP-1: The extended OSD tool route countdown timer HMI shall differentiate between route separation times and flow restriction separation times (NEW Sim L01).
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.							
ID 1.3.5-1	**Issue:** the concept solution provides additional information required by ATC roles and Flight Crew. Runway throughput will also be increased. More effort to build and maintain sufficient levels of SA will be needed (e.g., the visual scan of RWY controllers will take longer to complete). If there is insufficient time to complete the visual scan or build/update the mental picture human actors may not act when required, take the incorrect action or the correct action does not have the desired outcome.	OPEN	OBJ-37.1b-eOSD-10 OBJ-37-W3-DEMOP-HUP1-0021	Real Time Simulation Post-RTS end of run questionnaires Stakeholder Workshop	During the stakeholder workshop, participants explained that when using the extended OSD tool, they were thinking less about the geometry and situation, so they felt the SA would be better without the tool. While this would not be problematic during nominal operations (ATCOs felt like the RWY throughput increase would not significantly influence their SA), they considered it could raise issues in the system failure case, especially for inexperienced ATCOs. They stated that while the tool unlocks future features, trying to unwind in that scenario could sometimes be impossible ("the more helpful and encompassing the tool becomes, the more dramatic the fallback would be"). However, results of the post-simulation questionnaire showed that an acceptable level of situational awareness was achievable for all the reported levels of workload. Most entries (57.6%) indicated a very good SA level, with the TMA data feed scenario yielding the best results. Positive feedback from participants on seeing/hearing/understanding the information given by the tool for task completion (most of them agreed), as well as on mental model acquisition. There were no outstanding issues about potential distractions regarding the tool affecting SA, other than the potential for being distracted by corrupt data if the tool malfunctioned. No outstanding issues were identified in terms of scanning patterns.	REC-37-W3-DEMOR-HP-07: Further phases of development should investigate the capability of the controller to pick up the tasks and functions of the tool, should the tool fail.	REQ-37-W3-HP-2: The Tower Supervisor shall have the ability to turn the extended OSD tool off if required (NEW Sim L06).
HUMAN & SYSTEM							
Allocation of tasks (between the human and the machine) is acceptable							

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Arg. 2.1.1: The task allocation between the human and the machine is consistent with automation principle.							
ID 2.1.1-1	**Benefit:** The concept solution includes the provision of a system which automatically provides the ATCO with information about the Not Before Airbourne Time but does not provide an automatic detection of when the aircraft is airborne. This reduces the physical and cognitive workload of RWY controllers and therefore provides them with spare capacity. This may enable RWY controllers to handle more traffic in a specified period of time.	CLOSED	OBJ-37.1b-eOSD-11	Review of HP guidelines Stakeholder Workshop	ATCOs stated that they feel confident in the level of automation of the extended OSD tool and the task allocation between themselves and the tool. They felt like the tool represents a good "median" solution: considering that it cannot take into account all the external variables with high precision such that a generic algorithm would be devised for accurate and optimised day-by-day operation, they are still required to make judgements on the length of the take-off roll depending on those variables (which avoids total deskilling and ensures they are not overly reliant on the tool for issuing take-off clearances, making ATCOs feel like they are still in the loop), but they are supported in their controlling tasks.	N/A	N/A
ID 2.1.1-2	**Benefit:** The concept solution automates the calculation of the SID Spacing value to be applied between a non-wake pair of aircraft. This may enable RWY controllers to make quicker decisions about what instructions to give and when to give them to the aircraft on their frequency. It may also impact the speed of the decisions made by GND controllers and CDMs. This may create the necessary reduction in cognitive workload to reallocate resources to handling more aircraft (i.e., operational capacity/throughout may increase) The projected benefit that can be achieved if ATC/Flight crew are trainees or new validated may be reduced or negated as they work more slowly and expend a greater amount of cognitive effort when performing tasks.	CLOSED	OBJ-37.1b-eOSD-12 OBJ-37-W3-DEMOP-HUP1-0022	Real Time Simulation Stakeholder Workshop	The post-sim questionnaire data analysis and workshop discussion revealed that controllers not only felt that the extended OSD tool enabled them to achieve tasks in a timely manner, but also considered that by means of eliminating the mental calculations, they would be supported in faster decision making. Moreover, the taskload decrease would even allow for additional mental resources to reallocate to other relevant activities.	N/A	N/A
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.							
ID 2.1.2-1	**Benefit:** Automating the calculation of which separation standard and route spacing is required reduced the cognitive load for the RWY controller in normal operations."	CLOSE	OBJ-37.1b-eOSD-13 OBJ-37-W3-DEMOP-HUP1-0023	Real Time Simulation Planned: Assessment of benefit credibility	See Arg. ID 2.1.1-1	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							
ID 2.1.3-1	**Issue:** If the system fails such that the automated task is either done incorrectly, inefficiently or not done at all then RWY controllers will have to resume the responsibility of calculating which separation standard and route spacing should be applied. If a RWY controller's workload is already near to or at their physical or cognitive capacity thresholds, then this may result in an overload and therefore increase the risk of a safety incident (e.g., the instruction "cleared to take off" is given too early to the follower aircraft).	OPEN	OBJ-37.1b-eOSD-14. OBJ-37-W3-DEMOP-HUP1-0024	Real Time Simulation - system failure scenarios Post-RTS questionnaires Stakeholder Workshop	Participants felt like they could perform their tasks in a timely, efficient and accurate manner, including the failure scenarios. Nevertheless, during the stakeholder workshop, ATCOs emphasized the risks of startle, potential skill fade and workload increase for the transition to fallback mode in the case of system failure: "the more the tool is used the more the tool will be missed if it's not there anymore [..] the more helpful and encompassing the tool becomes, the more dramatic the fallback would be". As such, they expressed a preference for having a fallback matrix to follow, but they acknowledged that it could be difficult to do so during very busy times and that WL could therefore increase, especially for inexperienced ATCOs. Although an initial workload spike would occur for the fallback mode transition, this was considered to flatten to acceptable levels if the fallback procedure and matrix support the ATCO in an appropriate way. Coordination between the Tower ATC Supervisor and the Approach Supervisor is needed to switch between the modes of operation, but this was thought not to create and outstanding issues. Transition between modes of operation will also be eased if controllers have clear indicators regarding the status of the data feeds into the tool (i.e. TMA data feed)	REC-37-W3-DEMOR-HP-08: Consider currency training for manual mode operations (potentially during the yearly emergency training or other methods). REC-37-W3-DEMOR-HP-09 & REC-37-W3-DEMOR-HP-10: The concept should be expanded to include the impact on the total training pipeline (I.e., at the ITO and on unit).	REQ-37-W3-HP-3: The TMA data-feed and eOSD failure messages shall beplayed in a prominent location on the controller's electronic workstation position (NEW Sim L05).

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Arg 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.							
ID 2.1.4-1	**Issue:** Linked to previous arguments - The workload benefit gained by automated tasks may be negated by increases in RWY throughput and if the automation technology fails/operates in a degraded mode. For workload to be acceptable a balance between these factors needs to be achieved.	CLOSE	OBJ-37.1b-eOSD-15 OBJ-37-W3-DEMOP-HUP1-0025	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	Workload levels were considered acceptable for all the tested modes. ATCOs stated that in normal operations the extended OSD tool tool would help decrease workload and even allow mental capacity for other tasks. No outstanding concerns were expressed with regards to time available being less than today or the RWY throughput increase: they monitor aircraft anyway, so it doesn't require anything different from current operations, and the throughput would not increase enough to create significant WL increase. However, during the expert workshop, ATCOs expressed several concerns about degraded mode operations (see Arg. 2.1.3).	N/A	N/A
Arg. 2.1.5: Human actors can acquire an adequate mental model of the machine and its automated functions.							
ID 2.1.5-1	**Benefit:** EFPS at LHR already has built into its design and operation a process to indicate separation standards and route spacing. Linking the automated system to this pre-existing design and process should ensure that RWY controllers retain the ability to acquire an adequate mental model.	OPEN	OBJ-37.1b-eOSD-16 OBJ-37-W3-DEMOP-HUP1-0026	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	All participants agreed and strongly agreed with the fact that the tool supports them in creating an accurate mental model, which aids them in decision making and future state forecasting of separating aircraft. Still, during the expert workshop they stated that when using the tool, they were thinking less about the geometry and the situation, hinting at automation complacency and degraded SA. Although respondents claimed that the tool allowed for more time to plan, sequence and monitor, they felt like they could benefit from support from a departure manager (DMAN), which would help better separate aircraft based on predicted sequencing.	REC-37-W3-DEMOR-HP-04: Assess benefit credibility of DMAN support, run RTS with DMAN support	N/A
Performance of the technical systems allows for optimal human performance							
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.							
ID 2.2.1-1	**Issue:** Inaccurate information provision by the extended OSD tool may either go unnoticed by controllers because it remains credible. **As a result, they give a premature take-off clearance which could lead to a loss of MRS and/or SID spacing in LHR/TMA airspace (MAC AIM; WTE AIM). It could also increase the cognitive demand and physical tasks to be undertaken by controllers to such an extent that the TWR and/or TC ATCOs are working at the limit of their workload capacity**	OPEN	OBJ-37.1b-eOSD-17 OBJ-37-W3-DEMOP-HUP1-0027	Real Time Simulation - however, no scenario was run for the credibly corrupt data situation Stakeholder Workshop.	During the expert workshop, ATCOs emphasised that credibly corrupt data could be a critical issue, as both the experienced and inexperienced ATCOs would have difficulty in realizing that something is wrong, based on the type of traffic they have (the issue would be more prominent for inexperienced ATCOs: "If you don't have the knowledge to know what the separations really should be, there are minimal chances you'll even notice that"). Participants also felt like the corrupt data could create distractions if still displayed and expressed a preference for having the option to switch the tool off in such scenarios. Failure to address the credibly corrupt data scenario could have a serious negative impact on the safety of operations, as controllers could give a premature take-off clearance and/or be overwhelmed upon realising the issue and should be further studied in future project stages.	REC-37-W3-DEMOR-HP-02: Run RTS with credibly corrupt data scenario	REQ-37-W3-HP-2: The Tower Supervisor shall have the ability to turn the extended OSD tool off if required (NEW Sim L06).
Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.							
ID 2.2.2-1	**Issue:** The technical performance of the extended OSD tool may cause information to be provided either too late or too soon for it to be used by the controller effectively. **As a result, they give a premature take-off clearance which could lead to a loss of MRS and/or SID separation in LHR/TMA airspace (MAC AIM; WTE AIM). It could also increase the cognitive demand and physical tasks to be undertaken by controllers to such an extent that the TWR and/or TC ATCOs are working at the limit of their workload capacity**	OPEN	OBJ-37.1b-eOSD-18 OBJ-37-W3-DEMOP-HUP1-0028	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	Positive feedback was gathered from the ATCOs in terms of task completion for efficiency, accuracy and timeliness (most respondents strongly agreed). The respondents felt confident about using the tool in all modes of operation but emphasised the need for differentiating between the times displayed on the route countdown timer (route or flow restriction) in normal operations, the potential for workload spiking in failure modes and the difficulty of spotting credibly corrupt data in degraded modes. Information displayed too early or too late could cause confusion, but if it represents an indication of a degraded mode, ATCOs expressed the preference for having the option to switch the tool off in such scenarios. Overall, ATCOs felt that the tool is useful and the time of displaying the information is adequate for supporting their tasks. Activities and information exchange processes for technical problems were defined	REC-37-W3-DEMOR-HP-11: Reassess the extent to which information provided on the countdown timer is in timely manner for the user, run RTS.	N/A

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					in PJ02-01 OSED-SPR-INTEROP, but their efficiency should be assessed.		
Human-machine interface supports optimal human performance							
Arg. 2.3.1: The type of information provided satisfies the information requirements of the human.							
ID 2.3.1-1	**Benefit:** The information provided to RWY controllers by the extended OSD should enhance the speed of accuracy and confidence in their decisions regarding when to clear follower aircraft to take off. This may improve their rate of working and runway throughput.	OPEN	OBJ-37.1b-eOSD-19 OBJ-37-W3-DEMOP-HUP1-0029	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	Overall, participants felt that the extended OSD tool is helpful in supporting decision making and task achievement: most entries (75%) suggested an agreement that the extended OSD tool aided decision making for aircraft separation. All but one entry suggests that participant agreed (75%, n=12) and strongly agreed (16.7%, n=12) with the view that the tool supports them in creating an accurate mental model, thus helping to achieve their tasks in an accurate, timely and efficient manner. Additionally, a taskload decrease was quoted: this would allow for speedier decisions by eliminating the need for mental calculations. The ATCOs also felt like the tool would decrease WL, including when operating during the hours of darkness. decrease was quoted: this would allow for speedier decisions by eliminating the need for mental calculations. The ATCOs also felt like the tool would decrease WL, including when operating during the hours of darkness. The solution proposes that the HMI will ultimately display the most restrictive condition put forth by the wake separation timer and the route separation timer, with a TOGGLE possibility in case the controller wishes to see what the other condition is. If the displayed condition is the route separation but a wake separation also exists, the letter “w” will be displayed to clearly indicate that. As such, it was concluded that the HMI design offers an appropriate indication of wake vs non-wake pairs, which satisfies the information requirements of the human. Overall, participants claimed that this is a good, useful concept, that would benefit from refinements of route pairings and/or HMI. Most questionnaire entries (50%) quote the existence of mildly unpleasant deficiencies, rendering the system acceptable with minimal compensation to meet the required performance.	REC-37-W3-DEMOR-HP-12: Reassess once the HMI recommendations and requirements have been integrated into the tool design	N/A
ID 2.3.1-2	**Issue:** Information is provided to ALL identified roles. The system needs to give the right information to the intended recipient. Failure to do so may impact the ability of the recipient to take the correct action; for example, a RWY controller may not have sufficient time to incorporate the separation or spacing value into their plans and therefore the benefit will not be realised.	OPEN	OBJ-37.1b-eOSD-20 OBJ-37-W3-DEMOP-HUP1-0030	Real Time Simulation Stakeholder Workshop	The need for coordination between the Tower ATC Supervisor and the TMA Supervisor was identified, as was the need for the current operating mode (normal, degraded, failure) to be displayed on the CWPs of the Supervisors and Controllers. The supervisor should also be aware of the system failure to be able to turn the tool off, if such a procedure is implemented. If these needs are met, no outstanding issue was identified.	N/A	REQ-37-W3-HP-3: The TMA data-feed failure message and extended OSD failure message shall be displayed in a prominent location on the controller's electronic workstation position. (NEW Sim L05). REQ-37-W3-HP-2: The Tower Supervisor shall have the ability to turn the extended OSD tool off if required (NEW Sim L06).
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF 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]							
ID 2.3.6-3	**Benefit:** The information provided to RWY controllers by the extended OSD should allow them to achieve their goals in an effective, efficient and satisfactory way. This	OPEN	OBJ-37.1b-eOSD-21	Real Time Simulation	Participants stated they could perform their tasks in a timely, efficient and accurate manner.	REC-37-W3-DEMOR-HP-04: Assess benefit credibility of DMAN support, run RTS with	N/A

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	may improve their rate of working and runway throughput.		OBJ-37-W3-DEMOP-HUP1-0031	Post-RTS questionnaires Stakeholder Workshop	However, they highlighted that being supported by a type of departure manager (DMAN) would be useful, as tasks could be achieved more efficiently by knowing departure information in advance: “having the knowledge about departure sequence would be helpful and less distracting”.	DMAN support and analyse service delivery improvement	
ID 2.3.6-4	**Issue:** Information is provided to ALL identified roles. Information needs to be presented in a way that enables users to achieve their goals in an effective, efficient and satisfactory way. Failure to do so may impact the ability of the recipient to do this job safely and efficiently.	CLOSE	OBJ-37.1b-eOSD-22 OBJ-37-W3-DEMOP-HUP1-0032	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	See Arg. 2.3.6.-1	See Arg. 2.3.6-1	N/A
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]							
ID 2.3.7-2	**Issue:** A poorly designed HMI could increase the risk of human error.	OPEN	OBJ-37.1b-eOSD-23 OBJ-37-W3-DEMOP-HUP1-0033	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	While several participants found the HMI design reasonable and usable on ADIS, suggestions were put forth for fitting the timer on the EFPS, or the RWY bay strip, with a main preference for EFPS (controllers ultimately felt like including the timer on this display or any other frequently checked display would ease the integration of use, by building it into their usual scan). Additionally, creating a visual representation for the system failure instead of not displaying a time was proposed, as not displaying the time may not be a clear enough indication that the system has failed. An indication to make it clear what the time on the route separation timer is against (i.e., whether it relates to a route separation or flow restriction) was suggested, as was for crossing aircraft on the runway and the SID pairing the separation applies to (e.g., 1 & 2, or 1 & 3). In terms of the time format of the time value displayed on the countdown timer, ATCOs felt like it would be useful to have the ability for the controller to swap/have a choice: either time displayed only in seconds, or in both minutes and seconds - participants considered that there is potential for confusion between times (e.g., 140 s vs 1 min 40 s). Other aspects that were highlighted during the expert workshop were the prominence of the timer (making it more specific) and its location (preferably centrally placed on the strip). The solution proposes that the HMI will ultimately display the most restrictive condition put forth by the wake separation timer and the route separation timer, with a TOGGLE possibility in case the controller wishes to see what the other condition is. If the displayed condition is the route spacing but a wake separation also exists, the letter “w” will be displayed to clearly indicate that. It was concluded that the HMI design thus offers an appropriate indication of wake vs non-wake pairs.	REC-37-W3-DEMOR-HP-12: Reassess once the HMI recommendations and requirements have been integrated into the tool design	REQ-37-W3-HP-4: The extended OSD tool route countdown timer HMI shall differentiate between route separation times and flow restriction separation times (NEW Sim L01). REQ-37-W3-HP-5: The extended OSD tool route countdown timer shall indicate which SID pairing the separation time applies to (NEW Sim L02). REQ-37-W3-HP-6: The extended OSD tool wake and route countdown timers shall be displayed on a suitable HMI for the Air Departures Controller, e.g., the EFPS display (NEW Sim L03). REQ-37-W3-HP-3: The TMA data-feed and eOSD failure messages shall be displayed in a prominent location on the controller's electronic workstation position (NEW Sim L05).
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]							
ID 2.3.8-1	**Issue:** The interface for ATC should support their ability to perceive the requisite information, comprehend its meaning and use the information to predict traffic patterns in both a spatial and temporal manner. Failure	OPEN	OBJ-37.1b-eOSD-024	Real Time Simulation	Positive feedback from participants on seeing/hearing/understanding the information given by the tool for task completion (most of them	REC-37-W3-DEMOR-HP-12: Conduct HMI Development	REQ-37-W3-HP-6: The extended OSD tool route countdown timer shall indicate which

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	to do this may impact the efficiency and effectiveness of their performance which could impact on both service delivery and safety.		OBJ-37-W3-DEMOP-HUP1-0034	Post-RTS questionnaires Stakeholder Workshop	agreed). Most participants (75%) agreed that the extended OSD tool aided decision making for aircraft separation and spacing. However, the need for a visual representation (not an audio alert) of the system failure was highlighted, as opposed to not displaying a time, as the presented interface did not indicate the failure clearly enough and impaired SA. Moreover, an indication of what the time is against was quoted (i.e., whether it relates to a route separation or flow restriction), as this feature was not present in the SIM and participants felt like their workload increased and SA decreased while understanding what the indication referred to. The benefits of providing information on separation between a/c 1 and 3 was also discussed, with a view to avoid confusion with residual time (it's credible on easterlies) – but this was not deemed as a significant issue. A similar discussion was carried out for indicating crossing aircraft on the runway. Further consideration should be given to these proposals in the future stages of the project, as means of improving individual SA. For more on individual SA results, see Arg. 1.3.5.	Workshop to determine the design of failure messages REC-37-W3-DEMOR-HP-13: Assess the SA benefit credibility for integration of information on separation between a/c 1 and a/c 3, as well as on crossing aircraft on the runway	SID pairing the separation time applies to (NEW Sim L02). REQ-37-W3-HP-3: The TMA data-feed and eOSD failure messages shall be displayed in a prominent location on the controller's electronic workstation position (NEW Sim L05).
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]							
ID 2.3.9-1	**Issue:** The design of the HMI should support the level of individual situational awareness for ALL impacted ATC roles in order to support sufficient levels of team SA. Failure to do so could impact on the efficiency and effectiveness of the team.	OPEN	OBJ-37.1b-eOSD-025 OBJ-37-W3-DEMOP-HUP1-0014 OBJ-37-W3-DEMOP-HUP1-0035	Real Time Simulation Post-RTS questionnaires Stakeholder Workshop	It is assumed that the separation delivery tool deployment will not cause any change to team structure and team communication, with only a negligible difference in communication load and coordination. The current HMI design does not feature an indication for system failure or differentiation between times provided, which the ATCOs stated impaired their individual SA during the SIM run and should be reconsidered in the next stage of the project, as it could negatively impact team SA. According to PJ02-01-02 , the current operating mode shall be displayed on the CWPs of the Supervisors and Controllers, to ensure adequate team SA. The efficiency of the HMI design in maintaining team SA should be further studied in the next stage of the project.	REC-37-W3-DEMOR-HP-13: The efficiency of the HMI design in maintaining team SA should be further studied in the next stage of the project	REQ-37-W3-HP-4: The extended OSD tool route countdown timer HMI shall differentiate between route separation times and flow restriction separation times (NEW Sim L01). REQ-37-W3-HP-3: The TMA data-feed and eOSD failure messages shall be displayed in a prominent location on the controller's electronic workstation position (NEW Sim L05a).
HUMAN PERFORMANCE RELATED TRANSITION FACTORS							
Changes in competence requirements are analysed							
Arg. 4.2.3: Potential interferences between existing and new knowledge & skills are identified.							
ID 4.2.3-1	**Issue:** The extended OSD tool concept solution seeks to emulate the HMI solution identified in PJ02-01-02 for wake pairs. Failure to make the two solutions sufficiently distinct from one another could lead to interference between existing and new skill application.	CLOSE	OBJ-37.1b-eOSD-26 OBJ-37-W3-DEMOP-HUP1-0036	Discussion with SMEs Stakeholder Workshop	The solution proposes that the HMI will ultimately display the most restrictive condition put forth by the wake separation timer and the route separation timer, with a TOGGLE possibility in case the controller wishes to see what the other condition is. If the displayed condition is the route separation but a wake separation also exists, the letter "w" will be displayed to clearly indicate that. It was concluded that the HMI design thus offers an appropriate indication of wake vs non-wake pairs, and the interference risk does not pose an outstanding issue.	NA	NA

Table 7: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

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4.4.2 Maturity of the DEMO

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Maturity checklist for finalising the V3 assessment			
ID	**Question**	**Answer**	**Comments**
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes – Achieved	A change and impact assessment was conducted initially to identify the relevant argument. Risk assessments, subject matter expert scrutiny and real time simulations provided the evidence required to assess each of these arguments and either close it or generate recommendations and requirements to be considered in the next phase of developing this tool. Section 4.4.1 of this report provides the details.
2	Are the benefits and issues in terms of human performance and operability related to the proposed demo sufficiently assessed (i.e., on the level required for TRL7)?	Yes - Achieved	Each of the issues and benefits identified by the HF activities have been assessed through risk assessments, subject matter expert scrutiny and real time simulations provided the evidence required to assess the benefits and issues that were identified. Section 4.4.1 of this report provides the details.
3	Have all the parts of the demo/concept been considered?	Yes – Partial – Non Blocking	This HPAR reports on the activities undertaken to assess the ITARO W3 Sol 1B concept. The activities were based on the results of the change and impact assessment, which looked at all aspects of the concept. The HP Log (Appendix A) provides the details. It should be noted that due to simulation limitations only 27R and 09R operations were assessed in the RTS.
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes - Achieved	Potential interactions are listed in Section 4.1.4 of this report and were considered when formulating and assessing issues and benefits.
5	Is the level of human performance needed to achieve the desired system performance for the proposed demo consistent with human capabilities?	Yes - Partial- Non Blocking	Section 4.4.1 of this report provides the details; including recommendations and requirements to be included in the next maturity phase.
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on	No – Partial – Non Blocking	Evidence collected from HP activities indicates three benefits remain open: - ID 2.1.5-1. This benefit refers to combining the concept tool with pre-existing tools within LL

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	the overall strategic performance objectives/targets been analysed?		operations. Following the real time simulation, a recommendation was made to consider the benefit of a departure manager (DMAN) tool in the next phase of development. - ID 2.3.1-1. This benefit refers to increased accuracy, speed and confidence in decisions regarding giving take-off clearances to aircraft. Whilst the overall attitude of end users was positive, they collectively stated that refinements in the HMI would ensure this benefit would be optimized. - IS 2.3.6-1. This benefit refers to decreases in the time taken to complete relevant tasks thus increasing runway throughput. Following the real time simulation, a recommendation was made to consider the benefit of a departure manager (DMAN) tool in the next phase of development. Though these benefits remain open, there is no impact on the overall strategic performance objectives/targets. The recommendations simply seek to optimize the amount of benefit that can be delivered by this tool.
7	Has the proposed demo been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Yes – Partial Non-Blocking	The real time simulations and stakeholder workshops, which included end users, considered most operational modes and conditions (i.e., normal, abnormal and degraded). Some operational modes (e.g., runway direction) were missed due to simulation limitations. Where appropriate, recommendations and requirements were generated to consider and test the concept under other conditions which were suggested by end users. Section 4.4.1 provides details.
8	Do validation results confirm that the interactions between human and technology are operationally	Yes – Partial	Section 4.4.1 provides details of the recommendations and requirements associated with open issues.

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	feasible, and consistent with agreed human performance requirements?	Non-Blocking	
9	Has all relevant SESAR documentation been updated according to the HP activities outcomes (SPR-INTEROP/OSED)?	Yes – Partial Non-Blocking	Work is being undertaken to ensure that the appropriate cross-referencing between other SESAR documents (e.g., DEMOR Part 1) and this document, which described the outcomes, is completed.
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	No – Partial – Non Blocking	A number of issues and benefits remain "open". This is because the HP activities have enabled end users to make suggestions about improvements to the tool that will further enhance the associated KPA. These suggestions have been developed into a number of recommendations and requirements (see Appendix B and C).
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes – Partial - Non Blocking	A number of issues and benefits remain "open". This is because the HP activities have enabled end users to make suggestions about improvements to the tool that will further enhance the associated KPA. These suggestions have been developed into a number of recommendations and requirements (see Appendix 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?	Yes - Achieved	The Change and Impact assessment in July 2021 identified only a couple of issues that could influence the transition feasibility. Both have been closed based on the outcome of the real time simulations. Section 4.4.1 provides the details.
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.	No - Achieved	The Change and Impact assessment in July 2021 indicated that no changes to regulations would be needed.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes - Achieved	A number of issues and benefits remain "open". This is because the HP activities have enabled end users to make suggestions about improvements to the tool that will further enhance the

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			associated KPA. These suggestions have been developed into a number of recommendations and requirements (see Appendix B and C).

Table 8: DEMO Maturity Checklist Table

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5 References

Human Performance

[1] SESAR (2020). SESAR Human Performance Assessment Process V1 to V3 – including VLD, ed. 00.03.01

[2] DEMO Plan (DEMOP) - Part IV - Human Performance Assessment Plan

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Appendix A – HP Log

PJ37-W3-Sol1B-HP Log.xlsx

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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
REC-37-W3-DEMOR-HP-01	Other	In order to ensure appropriate allocation of tasks between TMA and Aerodrome controller, it is recommended that an assessment to determine what, if any, impact the concept could have on the TMA role is conducted	Analysis of post-sim HP questionnaire data indicates an increase in "Very good" situational awareness entries and a decrease in the high/very high workload levels in the case of the TMA data feed provision scenario as opposed to the Reference Scenario and the no TMA data-feed. Therefore, it appears that inclusion of the TMA traffic levels into the extended OSD best supports human performance.	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A
REC-37-W3-DEMOR-HP-02	New objective	To ensure all non-nominal conditions have been fully assessed, future risk assessments need to consider whether the scenario of controllers being presented with credible but corrupt data could lead to human error induced safety or service delivery problems.	SMEs emphasised that credibly corrupt data could be a critical issue, as both the experienced and inexperienced ATCOs would have difficulty in realising that something is wrong (the issue would be more prominent for inexperienced ATCOs).	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A
REC-37-W3-DEMOR-HP-03	New objective	To ensure that operating methods can be followed in an accurate, efficient and timely manner the description of the reference scenario should include the frequency of "inter-wake" [Pairwise] category flights.	End users discussed the impact that "inter-wake"[Pairwise] category flights could have on achieving the benefits associated with the tool. They suggested that this should be included in future calculations as they are a common occurrence	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			within the LHR operation.						
REC-37-W3-DEMOR-HP-04	New objective	To test the credibility of suggested improvements to the tool concept, future phases of development should actively investigate the benefit of using departure management tools to further support controllers.	During the Stakeholder Workshop ATCOs highlighted that being supported by a type of departure manager (DMAN) would be useful, as tasks could be achieved more efficiently in a timelier manner by knowing departure information in advance: “having the knowledge about departure sequence would be helpful and less distracting”.	Stakeholder Workshop (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A
REC-37-W3-DEMOR-HP-05	New objective	To ensure that any potential threats to communication effectiveness are eliminated and workload is not unduly impacted, future phases of development should assess the relative contribution communication metrics have on cognitive and physical loading.	A negligible increase in WL due to communication and coordination aspects with the ground controller was quoted during the RTS	Real Time Simulation (Section 4.4.1 of this document)	Ground	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A
REC-37-W3-DEMOR-HP-06	System design	To support controllers in degraded conditions, a fallback matrix should be developed	During the stakeholder workshop, the ATCOs acknowledged that in failure modes an immediate spike in workload could ensue, which normally would then flatten, with no significantly greater impact than today’s operations. Participants pointed out that the	Stakeholder Workshop (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			separation delivery tool can be highly beneficial especially in a restriction and departure heavy period, but that system failure in such a situation could be problematic. As such, they agreed that the business of operations, level of ATCO experience and the fallback matrix would play a defining role in the flattening of that curve. Having a very restrictive fallback matrix to follow during failure mode could work, but it would be difficult to follow during very busy times and it would increase workload.						
REC-37-W3-DEMOR-HP-07	New objective	To ensure that operations continue to be safe and effective during degraded conditions, assessments of controllers' capability to start performing the tasks that would normally be done by the tool should be investigated and a conclusion about the feasibility of the human being an appropriate fallback option made.	During the stakeholder workshop participants explained that when using the tool, they were thinking less about the geometry and situation, so they felt the SA would be better without the tool. While this would not be problematic during nominal operations (ATCOs felt like the RWY throughput increase would not significantly influence their SA), they considered it could raise issues in the system failure case, especially for inexperienced ATCOs. They stated that while the tool unlocks future features, trying to unwind in that scenario could sometimes be impossible ("the more	Stakeholder Workshop (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			helpful and encompassing the tool becomes, the more dramatic the fallback would be”).						
REC-37-W3-DEMOR-HP-08	New objective	To ensure that the capability of controllers to perform jobs safely and effectively remains consistent across normal, abnormal and degraded operating conditions, future phases of development should consider what changes to unit training and assessment plans might be needed to prevent skill fade; e.g., inclusion of key skills in ABES training.	During the stakeholder workshop, ATCOs emphasised the risks of startle, potential skill fade and workload increase for the transition to fallback mode in the case of system failure: “the more the tool is used the more the tool will be missed if it’s not there anymore [..] the more helpful and encompassing the tool becomes, the more dramatic the fallback would be”. As such, they expressed a preference for having a fallback matrix to follow, but they acknowledged that it could be difficult to do so during very busy times and that WL could therefore increase, especially for inexperienced ATCOs	Stakeholder Workshop (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A
REC-37-W3-DEMOR-HP-10	New objective	To ensure foundational training for TATCs is appropriate, future phases of development should investigate what, if any, changes may be required to the entire training pipeline for validating as a aerodrome controller.	During the stakeholder workshop, ATCOs emphasised the risks of startle, potential skill fade and workload increase for the transition to fallback mode in the case of system failure: “the more the tool is used the more the tool will be missed if it’s not there anymore [..] the more helpful and	Stakeholder Workshop (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			encompassing the tool becomes, the more dramatic the fallback would be". As such, they expressed a preference for having a fallback matrix to follow, but they acknowledged that it could be difficult to do so during very busy times and that WL could therefore increase, especially for inexperienced ATCOs						
REC-37-W3-DEMOR-HP-11	New objective	To ensure that suggested improvements to the design of the concept tool have the desired effect, future phases of development should reassess how much speed of, accuracy of and confidence in decision making is increased.	The solution proposes that the HMI will ultimately display the most restrictive condition put forth by the wake separation timer and the route separation timer, with a TOGGLE possibility in case the controller wishes to see what the other condition is. If the displayed condition is the route separation but a wake separation also exists, the letter "w" will be displayed to clearly indicate that. As such, it was concluded that the HMI design offers an appropriate indication of wake vs non-wake pairs, which satisfies the information requirements of the human. Overall, participants claimed that this is a good useful concept, that would benefit from refinements of route pairings and/or HMI. Most questionnaire entries (50%) quote the	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			existence of mildly unpleasant deficiencies, rendering the system acceptable with minimal compensation to meet the required performance.						
REC-37-W3-DEMOR-HP-12	System design	To ensure that suggested improvements to the design of the concept tool do not increase the risk of human error, established HMI design principles (e.g., ISO9241) and alerting philosophies should be consulted and design requirements generated.	Overall, participants felt that the extended OSD tool is helpful in supporting decision making and task achievement: most entries (75%) suggested an agreement that the extended OSD tool aided decision making for aircraft separation. All but one entry suggests that participant agreed (75%, n=12) and strongly agreed (16.7%, n=12) with the view that the tool supports them in creating an accurate mental model, thus helping to achieve their tasks in an accurate, timely and efficient manner. Additionally, a taskload decrease was quoted: this would allow for speedier decisions by eliminating the need for mental calculations. The ATCOs also felt like the tool would decrease WL, including when operating during the hours of darkness. decrease was quoted: this would allow for speedier decisions by eliminating the need for mental calculations. The ATCOs also felt like the tool would decrease WL, including when operating during the hours of darkness. The solution proposes that the HMI will ultimately display the most restrictive condition put forth by the wake separation timer and the route spacing timer, with a TOGGLE possibility in case the controller wishes to see what the other condition is. If the displayed condition is the route spacing but a wake separation also exists, the letter “w” will be displayed to clearly indicate that. As such, it was	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

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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
			concluded that the HMI design offers an appropriate indication of wake vs non-wake pairs, which satisfies the information requirements of the human. Overall, participants claimed that this is a good, useful concept, that would benefit from refinements of route pairings and/or HMI. Most questionnaire entries (50%) quote the existence of mildly unpleasant deficiencies, rendering the system acceptable with minimal compensation to meet the required performance.						
REC-37-W3-DEMOR-HP-13	New objective	To ensure that the UI continues to support building and maintaining situation awareness, future phases of development should assess the credibility that integrating information regarding the separation between the 1st and 3rd aircraft and regarding crossing traffic will deliver human performance benefits.	The benefits of providing information on separation between a/c 1 and 3 was also discussed, with a view to avoid confusion with residual time (it's credible on easterlies) – but this was not deemed as a significant issue. A similar discussion was carried out for indicating crossing aircraft on the runway. Further consideration should be given to these proposals in the future stages of the project, as means of improving individual SA.	Real Time Simulation (Section 4.4.1 of this document)	Air	ITARO W3 Sol 1B	To be analysed	To be analysed	N/A

Table 9: HP Recommendations

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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
REQ-37-W3-HP-1	System Design	The extended OSD tool route countdown timer HMI shall differentiate between route separation times and flow restriction separation times	Controllers expressed a preference for having a clear indication regarding the nature of the displayed time (whether it relates to a route separation or flow restriction), as not having the difference clearly expressed could lead to a workload increase.	Real Time Simulation (see Section 4.4.1 of HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A
REQ-37-W3-HP-2	System Design	The Tower Supervisor shall have the ability to turn the extended OSD tool off if required	During the stakeholder workshop participants explained that when using the tool, they were thinking less about the geometry and situation, so they felt the SA would be better without the tool. While this would not be problematic during nominal operations (ATCOs felt like the RWY throughput increase would not significantly influence their SA), they considered it could raise issues in the system failure case, especially for inexperienced ATCOs. They stated that while the tool unlocks future features, trying to unwind in that scenario could sometimes be impossible (“the more helpful and encompassing the tool	Stakeholder Workshop (Section 4.4.1 of the HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A

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			becomes, the more dramatic the fallback would be”).						
REQ-37-W3-HP-3	System Design	The TMA data-feed and eOSD failure messages shall be displayed in a prominent location on the controller's electronic workstation position	Participants felt like they could perform their tasks in a timely, efficient and accurate manner, including the failure scenarios. Nevertheless, during the stakeholder workshop, ATCOs emphasized the risks of startle, potential skill fade and workload increase for the transition to fallback mode in the case of system failure: “the more the tool is used the more the tool will be missed if it’s not there anymore [..] the more helpful and encompassing the tool becomes, the more dramatic the fallback would be”. As such, they expressed a preference for having a fallback matrix to follow, but they acknowledged that it could be difficult to do so during very busy times and that WL could therefore increase, especially for inexperienced ATCOs. Although an initial workload spike would occur for the fallback mode transition, this was considered to flatten to acceptable levels if the fallback procedure and matrix support the ATCO in an appropriate way. Coordination between the Tower ATC Supervisor and the Approach Supervisor is	Real Time Simulation (see Section 4.4.1 of HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A

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			needed to switch between the modes of operation, but this was thought not to create and outstanding issues.						
REQ-37-W3-HP-4	System Design	The extended OSD tool route countdown timer HMI shall differentiate between route separation times and flow restriction separation times	While several participants found the HMI design reasonable and usable on ADIS, suggestions were put forth for fitting the timer on the EFPS, the FDE or the RWY bay strip, with a main preference for EFPS (controllers ultimately felt like including the timer on this display or any other frequently checked display would ease the integration of use, by building it into their usual scan). Additionally, creating a visual representation for the system failure instead of not displaying a time was proposed, as not displaying the time may not be a clear enough indication that the system has failed. An indication to make it clear what the time on the route separation timer is against (i.e., whether it relates to a route separation or flow restriction) was suggested, as was for crossing aircraft on the runway and the SID pairing the separation applies to (e.g., 1 & 2, or 1 & 3).	Real Time Simulation (see Section 4.4.1 of HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A
REQ-37-W3-HP-5	System Design	The extended OSD tool route countdown timer shall indicate which SID pairing the separation time applies to	In terms of the displayed time indicating method, ATCOs felt like it would be useful to have the ability for the controller	Real Time Simulation (see Section 4.4.1 of HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A

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			to swap/have a choice: either time displayed only in seconds, or in both minutes and seconds - participants considered that there is potential for confusion between times (e.g., 140 s vs 1 min 40 s).						
REQ-37-W3-HP-6	System Design	The extended OSD tool wake and route countdown timers shall be displayed on a suitable HMI for the Air Departures Controller, e.g., the EFPS display	Other aspects that were highlighted during the expert workshop were the prominence of the timer (making it more specific) and its location (preferably centrally placed on the strip).	Real Time Simulation (see Section 4.4.1 of HPAR)	***Air/Ground***	ITARO-W3-Sol 01B	**To be analysed**	To be analysed	N/A

Table 10: HP Requirements

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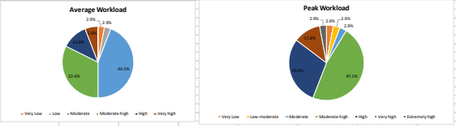
Appendix D – Real Time Simulation Data Set

NB. Click on worksheet to open fully

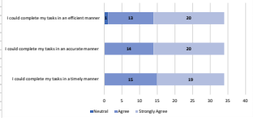
ID	Start time	Completion time	Email	Name	Name2	Role in run (AIR	What is todays' d	Which run have y	What was your AVERAGE work	What was your PEAK workloa	What were your key WORKLOAD DRIVERS? Please select all applic	Do you have any	Please rate the overall level of SITUATION AWARE	further comments on SITUATION AWARENESS relating to this last run?	I could complete	I could complete m	further observations relating to HUMAN FACTORS relating to this last run?	I could complete	AVE WL	PEAK WL	SA
2	9/12/22 10:08:30	9/12/22 10:12:31	anonymous			Air	12 sept	1st of the day	08 Very High	08 Very High	Complexity of traffic;Levels of traffic;		8 Good		Agree	Agree		Neutral	8	8	8
3	9/12/22 11:44:56	9/12/22 11:48:43	anonymous			Air	12 sept	2nd of the day	07 High	08 Very High	The design/operation of the sim (e.g.simism);Levels of traffic;Complexity of traffic;		9 Very Good		Agree	Agree		Agree	7	8	9
5	9/12/22 14:03:03	9/12/22 14:05:40	anonymous			Air	12 sept	3rd of the day	07 High	08 Very High	Levels of traffic;Complexity of traffic;The design/operation of the sim (e.g.simism);		9 Very Good		Agree	Agree		Agree	7	8	9
7	9/12/22 15:45:34	9/12/22 15:47:18	anonymous			Air	12sept	4th of the day	07 High	07 High	Levels of traffic;Complexity of traffic;		8 Good		Agree	Agree		Agree	7	7	8
8	9/13/22 10:55:24	9/13/22 10:57:00	anonymous			AIR	13/09/2022	1st of the day	05 Moderate	06 Moderate-High	Levels of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	5	6	9
9	9/13/22 10:57:05	9/13/22 11:43:12	anonymous			AIR	13/09/2022	2nd of the day	05 Moderate	06 Moderate-High	Levels of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	5	6	9
10	9/13/22 12:43:14	9/13/22 14:33:21	anonymous			AIR	13/09/2022	3rd of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	5	6	9
11	9/13/22 14:33:25	9/13/22 15:45:30	anonymous			AIR	13/09/2022	4th of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;The mental effort required to integrate the tool	Potential tiredness at	9 Very Good		Agree	Agree	As above - 4 runs for the	Agree	5	6	9
13	9/14/22 10:31:16	9/14/22 10:32:46	anonymous			Air	14 Sep	1st of the day	06 Moderate-High	07 High	Levels of traffic;	No	8 Good		Strongly Agree	Strongly Agree		Strongly Agree	6	7	8
15	9/14/22 11:56:08	9/14/22 11:56:51	anonymous			Air	14th Sep	2nd of the day	06 Moderate-High	07 High	Levels of traffic;		8 Good		Strongly Agree	Strongly Agree		Strongly Agree	6	7	8
17	9/14/22 14:00:22	9/14/22 14:02:47	anonymous			Air	14 Sep	3rd of the day	05 Moderate	06 Moderate-High	Levels of traffic;	Workload was reduced	9 Very Good	Tool allowed me to have	Strongly Agree	Strongly Agree	I used RSVA for one pair	Strongly Agree	5	6	9
19	9/14/22 15:33:19	9/14/22 15:39:45	anonymous			AIR	14.09.22	4th of the day	06 Moderate-High	07 High	Levels of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	6	7	9
21	9/15/22 9:42:18	9/15/22 9:54:35	anonymous			AIR	15.09.22	1st of the day	06 Moderate-High	07 High	Levels of traffic;Complexity of traffic;	Complexity references	8 Good		Agree	Agree	Almost launched a CPT	Agree	6	7	8
22	9/15/22 11:26:40	9/15/22 11:27:57	anonymous			AIR	15.09.22	2nd of the day	06 Moderate-High	07 High	Levels of traffic;	Workload was more mar	9 Very Good		Agree	Agree		Agree	6	7	9
23	9/16/22 13:31:37	9/16/22 13:33:24	anonymous			Air	15 sept	3rd of the day	05 Moderate	06 Moderate-High	Levels of traffic;The design/operation of the sim (e.g.simism);		10 Excellent		Strongly Agree	Agree		Strongly Agree	5	6	10
26	9/16/22 9:41:34	9/16/22 9:42:13	anonymous			AIR	16/09/2022	1st of the day	05 Moderate	06 Moderate-High	Complexity of traffic;Levels of traffic;		9 Very Good		Agree	Strongly Agree		Agree	5	6	9
28	9/16/22 11:25:19	9/16/22 11:26:33	anonymous			AIR	16/09/2022	2nd of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;		9 Very Good		Strongly Agree	Strongly Agree	Due to run repeat some	Strongly Agree	5	6	9
29	9/16/22 13:32:47	9/16/22 13:34:34	anonymous			AIR	16/09/2022	3rd of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;		9 Very Good		Agree	Agree		Strongly Agree	5	6	9
32	9/16/22 15:15:34	9/16/22 15:17:49	anonymous			AIR	16/09/2022	4th of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;		9 Very Good		Strongly Agree	Strongly Agree	Run recall probably affe	Strongly Agree	5	6	9
34	9/20/22 9:57:43	9/20/22 10:36:27	anonymous			AIR	20/09/2022	1st of the day	03 Low	04 Low-Moderate	Levels of traffic;		10 Excellent		Strongly Agree	Strongly Agree	I only looked at the clos	Strongly Agree	3	4	10
36	9/20/22 12:15:30	9/20/22 12:16:16	anonymous			AIR	20/09/22	2nd of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	5	6	9
37	9/20/22 14:07:41	9/20/22 14:09:02	anonymous			AIR	20/09/22	3rd of the day	02 Very Low	02 Very Low	Levels of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	2	2	9
41	9/21/22 10:11:16	9/21/22 10:13:20	anonymous			AIR	21/09/22	1st of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;Operational environment (e.g.runway direction);		9 Very Good		Agree	Agree		Agree	5	6	9
44	9/21/22 14:19:16	9/21/22 14:22:56	anonymous			AIR	21/09/22	3rd of the day	06 Moderate-High	07 High	Levels of traffic;Complexity of traffic;Operational environment (e.g.runway direction);		9 Very Good		Agree	Agree		Agree	6	7	9
46	9/21/22 15:53:50	9/21/22 15:54:32	anonymous			AIR	21.09.22	4th of the day	06 Moderate-High	07 High	Levels of traffic;		8 Good		Strongly Agree	Strongly Agree		Agree	6	7	8
48	9/22/22 9:32:11	9/22/22 9:34:32	anonymous			AIR	22/09/22	1st of the day	05 Moderate	06 Moderate-High	Levels of traffic;Complexity of traffic;Operational environment (e.g.runway direction);		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	5	6	9
50	9/22/22 11:02:33	9/22/22 11:05:58	anonymous			AIR	22.09.22	2nd of the day	06 Moderate-High	07 High	Levels of traffic;		9 Very Good		Agree	Strongly Agree		Agree	6	7	9
51	9/22/22 12:24:22	9/22/22 12:25:33	anonymous			AIR	22.09.22	3rd of the day	07 High	08 Very High	Levels of traffic;		9 Very Good		Agree	Agree		Agree	7	8	9
54	9/23/22 9:44:19	9/23/22 9:47:46	anonymous			AIR	23/09/22	1st of the day	06 Moderate-High	07 High	Levels of traffic;Complexity of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	6	7	9
55	9/23/22 11:31:12	9/23/22 11:32:48	anonymous			AIR	23/09/22	2nd of the day	06 Moderate-High	06 Moderate-High	Levels of traffic;		9 Very Good		Agree	Strongly Agree		Strongly Agree	6	6	9
56	9/23/22 14:10:51	9/23/22 14:12:47	anonymous			AIR	23/09/22	3rd of the day	06 Moderate-High	06 Moderate-High	Levels of traffic;		9 Very Good		Strongly Agree	Strongly Agree		Strongly Agree	6	6	9
57	9/26/22 10:04:41	9/26/22 10:07:46	anonymous			Air N	26.09.23	1st of the day	05 Moderate	06 Moderate-High	The design of eOSD Tool (HMI Design);Complexity of traffic;	Having to work out depa	9 Very Good		Strongly Agree	Strongly Agree	I tended to revert to lea	Strongly Agree	5	6	9
58	9/26/22 11:40:01	9/26/22 11:42:57	anonymous			Air	26 sept	2nd of the day	08 Very High	09 Extremely High	Levels of traffic;Operational environment (e.g.runway direction);	No	9 Very Good		Agree	Agree		Agree	8	9	9
59	9/26/22 14:02:41	9/26/22 14:12:20	anonymous			AIR	26.09.22	3rd of the day	05 Moderate	05 Moderate	Complexity of traffic;Levels of traffic;	Baseline run so no issue	9 Very Good	No	Strongly Agree	Strongly Agree	No	Strongly Agree	5	5	9



Average workload	Count	
Insignificant	0	0.0
Very Low	1	2.9
Low	1	2.9
Low-moderate	0	0.0
Moderate	15	44.1
Moderate-high	11	32.4
High	4	11.8
Very high	2	5.9
Extremely high	0	0
Task Unsustainable	0	0
	34	
Insignificant	0.0%	
Very Low	2.9%	
Low	2.9%	
Low-moderate	0.0%	
Moderate	44.1%	
Moderate-high	32.4%	
High	11.8%	
Very high	5.9%	
Extremely high	0.0%	
Task Unsustainable	0.0%	

Workload drivers	Percentage of participants who selected it
Levels of traffic	55.9
Operating techniqus/procedures associated with the eOSD tool	0.0
Complexity of traffic	30.5
The design/operation of the sim (e.g., simism)	5.1
The design of eOSD tool (HMI Design)	1.7
Operational Environment (e.g., runway direction)	6.8
The mental effort required to integrate the tools information into my plan	1.7
	59

	Neutral	Agree	Strongly Agree
I could complete my tasks in a timely manner	0	15	19
I could complete my tasks in an accurate manne	0	14	20
I could complete my tasks in an efficient manne	1	13	20



PEAK WORKLOAD	COUNT	
Insignificant	0	0
Very Low	1	0.01694915
Low	0	0
Low-moderate	1	0.01694915
Moderate	1	0.01694915
Moderate-high	16	0.271186441
High	10	0.169491525
Very high	4	0.06779661
Extremely high	1	0.01694915
Task Unsustainable	0	0
	34	
	0.0	
	2.9	
	0.0	
	2.9	
	2.9	
	47.1	
	29.4	
	11.8	
	2.9	
	0.0	

SA	Count	
Excellent	2	5.9%
Very good	26	76.5%
Good	6	17.6%
	34	
Excellent	30.5%	
Very good	57.6%	
Good	11.9%	

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