

SESAR Solution PJ.02-01-06 SPR-INTEROP/OSED for V3 - Part IV - Human Performance Assessment Report

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PJ.02-W2 AART

AIRPORT, AIRSIDE AND RUNWAY THROUGHPUT

This Human Performance Assessment Report is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874477 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document contains the Human Performance (HP) assessment report for the SESAR 2020 Wave 1 SESAR Solution PJ.02-01-06 (WTS (for Departures) based on Static Aircraft Characteristics) which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements. The scope of this report embraces all three solution concepts (WDS-D, PWS-D and OSD) assessed by NATS, Eurocontrol, DLR and ENAIRE. A set of desk-top exercises, workshops with partners and end-users were utilised as the source of the information for the HP assessment, as well as Real Time Simulations, where findings were tested, analysed, and appropriate recommendations identified.

The following is a list of activities conducted in PJ02-01 Wave 1 :

- Partner workshop for all concepts held in Madrid in July 2018
- NATS internal user WebEx, November 2018
- Partner workshop for all concepts held in Bretigny in October 2018
- Eurocontrol Real Time Simulations (RTS)
- Pilot- ATCO Workshop conducted by Eurocontrol in Paris in January 2019
- NATS Real Time Simulations (RTS) 5
- Post-RTS5 workshop held at Heathrow in March 2019
- ENAIRE RTS 6
- Post-validation workshop held at NATS in July 2019

In SESAR 2020 Wave 2 PJ.02-01-06 a flight simulation for S-PWS-D was conducted to assess the acceptability of the reduced separations under S-PWS from a pilots' perspective.

The criteria of the V3 Maturity assessment have been met.

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1 Executive Summary

This document contains the Human Performance Assessment for the application of the SESAR Solution PJ.02-01-06 (WTS (for Departures) based on Static Aircraft Characteristics) in capacity constrained European Airports including Heathrow, Charles De Gaulle, Vienna and Barcelona. The report presents the assurance that the Human Performance Requirements for the V1-V3 phases are complete, correct and realistic, thereby providing all material to adequately inform the SESAR Solution PJ.02-01-06 development and validation.

This Human Performance Assessment Report (HPAR) is contributing to the Operational Service and Environment Definition (OSED), Safety and Performance Requirements (SPR), Interoperability (INTEROP) Requirements, and Technical Specifications (TS), and Interface Requirement Specifications (IRS).

This document specifies the SESAR Solution PJ.02-01-06 human performance assessment results in the scope of the operational scenarios designed and validated by ENAIRE, EUROCONTROL, DLR and NATS, which took place between February 2018 and July 2019.

As well as the results from the SESAR 2020 Wave 2 PJ02-01-06 flight simulation to assess the acceptability of the reduced separations under S-PWS from a pilots' perspective.

This Human Performance Assessment Report aggregates the main Solution scenarios of the SESAR Solution PJ.02-01-06 as follows:

- Departures Concepts Solutions:
 - Pairwise Separations for Departures (PWS-D) with Optimised Separation Delivery (OSD) tool support;
 - Weather Dependent Separations for Departures (WDS-D) with WDS-D tool support and Enhanced OSD tool support;
 - RECAT-EU separation for Departures with OSD support tool.

Internal and external workshops with end users were held to identify areas of Human performance where changes were expected. Together with the related issues or benefits, these were recorded and categorised within the Human Performance argument structure, which subsequently formed a basis for a list of Objectives for Real Time Simulations and Post-simulation workshops, where the relevant subject-matter experts participated.

The Issues and/or Benefits were identified within all the four HP Arguments (and their sub-categories), which are listed as follows:

- **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**

The following is the summary of the findings for all departures concepts:

A satisfactory number of data-points were collected during NATS RTS5, Eurocontrol and ENAIRE Validation exercises for each scenario, with the majority of the HP areas covered in accordance with the Issues and Benefits previously identified within the four High-level HP arguments. The only area that was not covered in the NATS RTS 5 simulation exercise was the Airport Tower Supervisor role and their responsibilities with respect to the application of the WDS-D Solution. This was due to the limitations in the NATS Aerodrome Simulator environment.

No major detrimental impact on HP was found in the RECAT-EU, PWS-D and WDS-D scenarios compared to the reference scenario. A clear benefit of the employed of the OSD/Enhanced tool was identified with respect to controller mental workload, time management and task organisation.

However, the dynamic application of the Weather-dependent solutions (WDS-D) may result in the controller investing effort on optimising the departure sequence without the reduced separation benefits being realised as meteorological conditions could change with little predictability.

The identified HP issue, which is applicable to all solutions with the use of the OSD tool, the controller following the countdown timer and omitting to account for higher SID separation rules materialised during the RTS5 exercise and during the PostRTS5 stakeholder workshop. This issue will be addressed in future project activities – the generated Recommendations and Requirements specify details. It is foreseen that after the mandatory Requirements and feasible Recommendations have been completed, HP risks will be mitigated to an acceptable level.

The flight simulation (VALEXE 11) conducted in SESAR 2020 Wave 2 PJ02-01-06 showed that the reduced separations under the S-PWS-D are acceptable to the pilots. This is based on pilots' perception of the impact severity of wake encounters experienced during the flight simulation for the selection of reference aircraft pairs.

A set of Recommendations and Requirements has been identified. It is foreseen that after the mandatory Requirements and feasible Recommendations have been completed, HP risks will be mitigated to an acceptable level.

A variety of activities yielded evidence for human performance. Limitations within the V3 phase of this project were in:

- The Real Time simulation environment (i.e. no live data from operations);
- Lack of availability of Tower Supervisor role;
- Lack of availability of Airline representatives.

In accordance with the Issues and Benefits previously identified within the four High-level HP arguments, evidence was gathered and a set of Recommendations and Requirements was produced, where applicable.

No major detrimental impact on HP was found in the solution scenarios in comparison to the Reference scenario.

When the Departures concept is being considered, prior to industrialisation, a more detailed investigation will be required with respect to:

- Clarifying the Tower Supervisor's responsibilities, in particular for the WDS-D solution;
- OSD Tool + Enhanced OSD Tool assurance;

- Final HMI design;
- Controller training;
- Airline engagement.

A clear benefit of the OSD/Enhanced OSD tool was identified within all scenarios with respect to improving controller mental workload, time management and task organisation.

2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the result of the activities conducted according to the Human Performance (HP) assessment process [2] in order to derive the HP assessment report for PJ.02-01-06 WTS (for Departures) based on Static Aircraft Characteristics in the frame of SESAR 2020 including requirements and recommendations.

PJ.02-01-06 encompasses the following operational improvements:

- WDS-D (using OSD)
- PWS-D (using OSD)

The SESAR Wave 1 Solution PJ.02-01 design and validation work was organized according to three main threads, defined via the following operational scenarios:

EUROCONTROL Thread

- RTS3a: PWS-A with ORD for Arrivals, and PWS-D with OSD for Departures, on single RWY in mixed mode, for Vienna airport;
- RTS4a: PWS-A with ORD for Arrivals, and PWS-D with OSD for Departures, on a single RWY in mixed mode, for Vienna airport;
- RTS4b: PWS-A and WDS-A with ORD for Arrivals, and PWS-D and WDS-D with OSD for Departures, on CSPR RWYs in segregated and mixed mode, for Paris CDG airport.

NATS Thread

- RTS5: PWS-D with OSD, WDS-D with OSD and RECAT-EU with OSD for Departures, on dependent parallel RWYs in segregated mode, with a small number of arrivals landing on the departure runway under tactically enhanced arrival management, and encompassing transition in case of degraded mode, for London Heathrow airport.

ENAIRES Thread

- RTS6: WDS-D with OSD for Departures, focused on Departures (no validation for ARR, just impact via workload, go around interactions etc.), for Barcelona airport.

In SESAR 2020 Wave 2 PJ02-01-06 there was only one work thread:

EUROCONTROL Thread

- VALEXE11 Flight simulation: S-PWS-D reduced separations are acceptable to pilots from a wake impact severity perspective.

The above work share threads integrate back into the concepts threads as below. For more information about the concepts, please see Section 3.2 in this document or Section 3 in the SPR-INTEROP/OSED Part I.

The departures concepts solutions consist of Wake Turbulence Separations for Departure based on Static Aircraft Characteristics (AO-0323), Optimised Separation Delivery for Departure (AO-0329) and Weather-Dependent Reductions of Wake Turbulence Separation for Departure (AO-0304).

2.1.1 OSD Tool

The Optimised Separation Delivery for Departure is the controller tool support to facilitate the Tower Runway Controller to consistently and efficiently deliver to the more efficient wake turbulence separations that have been developed and are under approval by EASA through the re-categorisation programme by the RECAT-EU-PWS activities. These more efficient wake turbulence separations currently consist of the time-based seven wake category (7-CAT) based wake separation minima, or the distance-based 96 x 96 aircraft type based pairwise wake separation minima in conjunction with the 20 wake category-based (20-CAT) wake separation minima for departure pairs involving other aircraft types.

2.1.2 PWS-D

In SESAR 2020 Wave 2, an aircraft type based pairwise wake separation minima has been developed in conjunction with the development of the time-based variant of the 20-CAT wake category-based wake separation minima. The time-based seven wake category (7-CAT) PWS based wake separation minima was applied (AO-0323) in the EUROCONTROL RTSs 3a, 4a and 4b, whilst for the NATS and ENAIRE RTSs 5 and 6 respectively, a draft time based 96 x 96 aircraft type pairwise wake separation minima, and the time based 20-CAT wake separation minima for departure pairs involving other aircraft types was applied. The time based matrices were established using the method agreed with EUROCONTROL as described in the SPR-INTEROP/OSED Part I.

The PWS for departures will be supported by Optimised Separation Delivery (OSD - AO-0329) tool.

2.1.3 WDS-D

The Weather Dependent Reduction of Wake Turbulence Separation for Departure is the conditional reduction or suspension of the wake separation minima for departure operations, applicable under pre-defined wind conditions. This is on the basis that under the pre-defined wind conditions the wake turbulence generated by the lead aircraft is either wind transported out of the path of the follower aircraft on the initial departure path or has decayed sufficiently to be acceptable to be encountered by the follower aircraft on the initial departure path. Two pre-defined wind conditions are under consideration, a minimum of 6 knots to 10 knots crosswind to provide for crosswind transport with 90s reduced wake separation minima, and a minimum of a 10 knots wind speed in conjunction with 60s reduced wake separation minima (or more likely a delta reduction of the wake separation) provided there is either sufficient wake decay or transport of the wake vortices. Additionally, different rotation positions and climb profiles are also being considered with respect to facilitating wake

avoidance. Initial analysis of data indicated that the currently-operated different rotation positions and climb profiles are not sufficiently consistent to ensure wake avoidance.

The main development and validation needs include the specification and approval of the wake separation rules with particular focus on the safety assurance evidence, the development and validation of the controller tool support with particular focus on the human performance and safety assurance evidence, and the development and validation of the business case with particular focus on the benefits evidence.

2.2 Intended readership

Stakeholders are to be found among:

- ANS providers;
- ATM infrastructure and equipment suppliers;
- Airspace users;
- Airport owners/providers;
- Affected NSA;
- Affected employee unions;

Furthermore, the intended readership is the SESAR Solution PJ.02-01-06 project members, the other solutions in SESAR Project PJ02 Increased Runway and Airport Throughput, the related solutions in SESAR Project PJ01 Enhanced Arrivals and Departures, the related solutions in SESAR Project PJ04 Total Airport Management, the related solutions in SESAR Project PJ09 Advanced Demand & Capacity Balancing, the related transversal SESAR Projects PJ19 and PJ22, and all impacted and interested stakeholders.

2.3 Human performance work schedule within the Solution

The Human Performance Assessment for the PJ.02-01-06 Solution was conducted according to the Validation Plan, HPAP.

The actual work schedule for the HP Assessment activities has diverted slightly from the HPAP due to partner and end-user availability. The following table lists the conducted activities and dates:

Activity	Dates	Location
Eurocontrol Workshop on PJ.02-01-06 Solution	29-30 October 2018	EEC Bretigny, France
NATS Heathrow WebEx	28 November 2018	NATS/WebEx
Real Time Simulations 5 (RTS5)	12 days in total between January 18, 2019 and February 11, 2019	NATS CTC, E2 Aerodrome Simulator
Post-Simulation Workshop – internal	21 March 2019	NATS CTC
Post-Simulation Workshop with external participants	28 March 2019	Heathrow Airport
Flight simulation	5 days in September & October 2022 2 days in December 2022	AMST Amsterdam Austria Aviation Academy, Vienna

2.4 Structure of the document

This section describes the content of the different chapters

The Part IV - HPAR of the SESAR Solution PJ.02-01-06 SPR-INTEROP/OSED consists of four main sections and four appendices. Each section, and appendix, addresses each of the SESAR Solution PJ.02-01-06 WTS (for Departures) based on Static Aircraft Characteristics concepts solutions.

- **Section 1:** Executive Summary of the brief description of the concepts solutions and the associated research needs gaps and issues;
- **Section 2:** Introduction covering the purpose of the document, the scope, the intended readership and the glossary of terms and the list of acronyms;
- **Section 3:** The Human Performance Assessment Process: Objective and Approach detailing the HP assessment process;
- **Section 4:** Human Performance Assessment collecting the evidences of each step of the process for the different concepts;
- **Appendix A:** Additional HP activities conducted for each concept, including the output or reports from HP activities conducted that are not described in the main body;
- **Appendix B:** HP Recommendations Register including the list of HP recommendations gathered in the project for each concept;
- **Appendix C:** HP Requirements Register including the list of HP Requirements gathered in the project for each concept;
- **Appendix D:** HP Log including the HP Log of each concept in the project scope.

2.5 Acronyms and Terminology

Term	Description
a/c	Aircraft
ADIS	Airport Display Information System
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATS	Air Traffic Services
CREDOS	Crosswind Reduced Separations for Departure Operations
EARTH	Enhanced Runway Throughput
EFPS	Electronic Flight Progress Strips
FDE	Flight Data Entry
HMI	Human Machine Interface
HPAP	Human Performance Assessment Plan
HPAR	Human Performance Assessment Report

LOS	Loss of Separation
MRS	Minimum Radar Separation
N/A	Not applicable/ Not Available
NBAT	Not-Before-Airborne-Time
NBTOT	Not-Before-Take-Off-Time
Nm	Nautical Mile
OBJ	Objectives
OI	Operational Improvement
ORD	Optimised Runway Delivery
OSD	Optimised Separation Delivery
OSED	The Operational Service and Environment Definition
PJ	Project
PWS-A	Pairwise Separation on Arrivals
PWS-D	Pairwise Separation on Departure
RSVA	Reduced Separation in the Vicinity of an Airfield
RTS	Real Time Simulation
RWY	Runway
SESAR	Single European Sky ATM Research
SID	Standard Instrument Departure
SPR	Safety and Performance Requirements
TBD	To be Defined
TEAM	Tactically Enhanced Arrivals Mode
TMA	Terminal Manoeuvring Area
TWR	Tower
VALP	Validation Plan
WDS-A	Weather-Dependant Separation on Arrival
WDS-D	Weather-Dependant Separation on Departure

WSTOT	Wake Separation Take-Off Time
WV	Wake Vortex
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.
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 Argument	An HP argument is an HP claim that needs to be proven through the HP Assessment Process.
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 SESAR Solutions into larger clusters (e.g. 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, OSD, 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.

Table 1: Acronyms and terminology

3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP Assessment process is described in detail in [1] is to ensure that HP aspects related to SESAR technical and operational developments are systematically identified and managed. The SESAR HP assessment process uses an ‘argument’ and ‘evidence’ approach. An HP argument is an ‘HP claim that needs to be proven’. The aim of the HP assessment is to provide the necessary ‘evidence’ to show that the HP arguments impacted have been considered and satisfied by the HP assessment process. This includes the identification of HP requirements and recommendations to support the design and development of the concept.

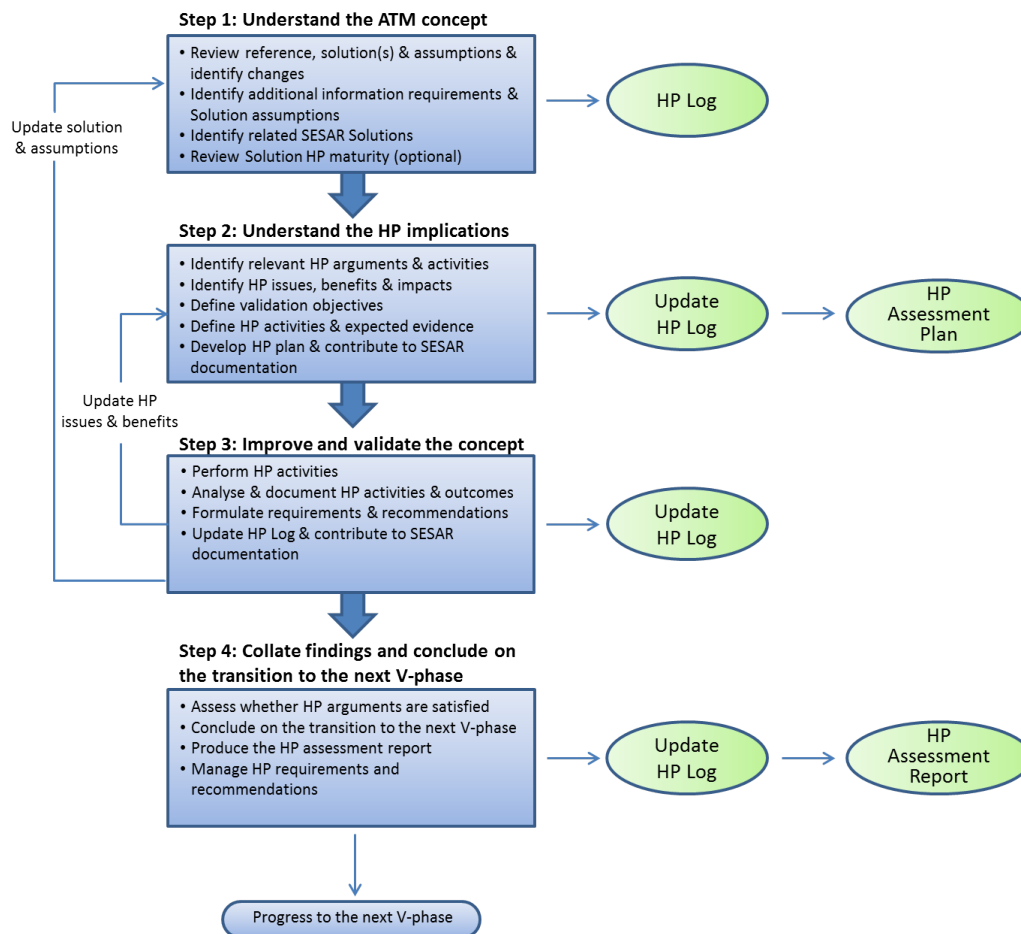


Figure 1: Steps of the HP assessment process

The HP assessment process is a four-step process. Figure 1 provides an overview of these four steps with the tasks to be carried out and the two main outputs (i.e. HP plan and HP assessment report). In addition, an HP Log for each of the concepts is maintained throughout the lifecycle of the Solution in which all the data/ information obtained from all HP activities conducted as part of the HP assessment is documented. The HP Logs [Appendix A] are a living document that are continuously updated and / or added to as the SESAR Solution progresses.

4 Human Performance Assessment

This section is split in 4 subsections providing Step 1, Step 2, Step 3 and Step 4.

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

The description of the reference scenario can be found in the Departures HP Log (Solution & Concept Info tab), Appendix D.2

4.1.2 Description of solution scenario

The description of the solution scenarios can be found in the Departures HP Log (Solution & Concept Info tab), Appendix D.2

4.1.3 Consolidated list of assumptions

The consolidated list of assumptions can be found in the Departures HP Log (Solution & Concept Info tab), Appendix D.2

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

The list of related SESAR solutions can be found in the Departures HP Log (Solution & Concept Info tab) Appendix D.2

4.1.5 Identification of the nature of the change

The identification of nature of change can be found in the Departures HP Log (Change & Argument Identification tab).

4.2 Step 2 Understand the HP implications

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

The list of relevant arguments, HP issues and benefits of HP activities can be found in the Departures HP Log (Issue-Objective Outcome tabs for solutions), Appendix D.2.

4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

4.3.1.1 In SESAR 2020 Wave 1 PJ02-01

- Partner workshop for all concepts held in Madrid in July 2018;
- NATS internal user WebEx, November 2018;
- Partner workshop for all concepts held in Bretigny in October 2018;
- Eurocontrol Real Time Simulations (RTS4a);
- Eurocontrol Real Time Simulations (RTS4b);
- NATS Validation Real Time Simulations (RTS5);
- Post-RTS5 workshop held at Heathrow in March 2019;
- ENAIRE RTS 6;
- Post-validation workshop held at NATS in July 2019.

Activity 1. Madrid Workshop	
Description	NATS, ECTL and ENAIRE workshop
Arguments & related issues addressed	HP Arg. 1-4
HP objectives	See HP Log for a full list of objectives (e.g. Appendix D.2)
Tools / Methods selected out of the HP repository	Subject matter expert review of HP objectives and proposed validation methods
Summary of the HP activity	Solution tool HMI design review, proposal of validation methods and data collection to collect human performance data/validate HP objectives

Table 2: Description of Activity 1

ACTIVITY 2.	
Description	WebEx with Solution lead, HP Lead and Heathrow tower controller
Related Arguments	HP Arg. 1-4 Supervisor role discussed Toll benefits clarified
HP objectives	See HP Log Appendix A, relevant objectives in Argument 1 and 2

Issues to be addressed / investigated from issues analysis	Argument 1 – In specific the role of the Supervisor was discussed wrt their current high workload, Task analysis detailed, tool benefits clarified wrt WL
Tools/Methods selected out of the HP repository	Semi-structured interview with end user
Summary of the HP activity	See HP Log Appendix TBD, Recommendation All tab and Requirements All tab

Table 3: Description of Activity 2

ACTIVITY 3.	
Bretigny partner workshop October 2018	
Description	NATS, ECTL workshop with the participation of ATCO's (Austrocontrol, Eurocontrol)
Related Arguments	HP Arg. 1-4
HP objectives	See HP Log Appendix A, relevant objectives in Argument 1 -4
Issues to be addressed / investigated from issues analysis	Hazards wrt early take-off – loss of WV separation or SID separation
Tools/Methods selected out of the HP repository	Semi-structured interview with end users, expert input from NATS and Eurocontrol Safety and HP See columns R to U in the HP Log, Tab Issue-Objective-Outcome
Summary of the HP activity	See HP Log Appendix A, Recommendation All tab and Requirements All tab

ACTIVITY 4.	
NATS RTS 5	
Description	Validation activity in a high-fidelity simulation environment, see column T in the Issue-Objective-Outcome tabs in the HP log, Appendix D.2 for details
Related Arguments	HP Arg. 1-4
HP objectives	See HP Log Appendix D.2, relevant objectives in Argument 1 -4
Issues to be addressed / investigated from issues analysis	The entire list of Issues identified in the Issue-Objective-Outcome tabs in the HP Log, Appendix D.2 HMI feedback

Tools/Methods selected out of the HP repository	See columns R to U in the HP Log, Tab Issue-Objective-Outcome
Summary of the HP activity	See HP Log Appendix D.2, Recommendation All tab and Requirements All tab

ACTIVITY 5. Post-RTS5 workshop held at Heathrow in March 2019	
Description	Safety and Human Performance post-RTS5 workshop.
Related Arguments	See Appendix A2 for details
HP objectives	To provide HP assurance for outstanding hazards identified in RTS5.
Issues to be addressed / investigated from issues analysis	See Appendix A2 for details
Tools/Methods selected out of the HP repository	HAZID workshop using Bowtie method.
Summary of the HP activity	See Appendix A2 for details

ACTIVITY 6. Eurocontrol RTS4a	
Description	Activity assessed the application of Static Pairwise Separations (S-PWS) - wake turbulence separations for departing aircraft based on static aircraft characteristics (AO-0323) integrated in a realistic environment in mixed mode runway operations.
Related Arguments	HP Arg.1-4
HP objectives	<p>Ref. Scenario- The wake turbulence separation scheme applied in the reference scenario for the arriving and departing aircraft was the current wake turbulence separation scheme used in the Vienna approach and tower environment, i.e. Distance Based ICAO wake turbulence separation scheme:</p> <p>For aircraft category pairs with no defined WT separation then the MRS was applied. This was typically 3 NM although can be 2.5 NM under certain conditions prescribed in ICAO Doc 4444 [41] or as prescribed by the appropriate ATS authority.</p> <p>No visual separations were allowed.</p>

Issues to be addressed / investigated from issues analysis	Controller ability to apply 2.5MN Minimum Radar Separation.
Tools/Methods selected out of the HP repository	Observations, questionnaires
Summary of the HP activity	For this simulation, it was considered that the conditions were met such that 2.5NM MRS was applied.

ACTIVITY 7.	Eurocontrol RTS4b
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Description	<p>The first aim was to assess the operational feasibility of time-based static Pairwise Separation (S-PWS-A - AO-0310) with Optimised Runway Delivery (ORD - AO-0328) for arriving aircraft in a Closely Spaced Parallel Runway (CSPR) environment. The second aim was to assess the operational feasibility of the static Pairwise Separations for departing aircraft (S-PWS) based on static aircraft characteristics (AO-0323) under partially segregated runway departure operations with Optimised Separation Delivery (OSD - AO-0329).</p> <p>Arrivals: The wake turbulence separation scheme applied in the reference scenario was the current wake turbulence separation scheme used in the Paris CDG approach environment, i.e. Distance Based RECAT-EU. Departures: For departures, the ICAO time-based wake turbulence separation scheme was applied with no tool support as is done in current operations.</p>
Related Arguments	HP Arg.1-4
HP objectives	Please see the HP Log, Appendix D.1
Issues to be addressed / investigated from issues analysis	Please see the HP Log, Appendix D.1
Tools/Methods selected out of the HP repository	Observations, questionnaires
Summary of the HP activity	Please see the HP Log, Appendix D.1

ACTIVITY 8.	ENAIRES RTS6
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Description	ENAIRES RTS 6 5 measured runs, 3 controllers, 50 min
Related Arguments	HP Arg. 1-4

HP objectives	Please see the HP Log, Appendix D.2
Issues to be addressed / investigated from issues analysis	Please see the HP Log, Appendix D.2
Tools/Methods selected out of the HP repository	Observations, questionnaires
Summary of the HP activity	Please see the HP Log, Appendix D.2

ACTIVITY 9.	Partner workshop at NATS July 2019
Description	Presentation of findings
Related Arguments	HP Arg. 1-4
HP objectives	All relevant under HP Arguments 1-4 HP findings Formal agreements
Issues to be addressed / investigated from issues analysis	Review and submission to SJU
Tools/Methods selected out of the HP repository	n/a
summary of the HP activity	VALR, HPAR, SAR and PAR update, SJU template use coordination

4.3.1.2 In SESAR 2020 Wave 2 PJ02-01-06

- VALEXE 11 – WISA Flight simulation .

Activity 1.	Madrid Workshop
Description	ECTL Wake Impact Severity Assessment (WISA) flight simulation campaign
Arguments & related issues addressed	HP Arg. 4
HP objectives	See HP Log for a full list of objectives (e.g. Appendix D.2)

Tools / Methods selected out of the HP repository	Real time flight simulation
Summary of the HP activity	A flight simulation with wake encounters under ICAO and S-PWS to provide evidence that the reduced separations under S-PWS were acceptable to pilots from a wake impact severity perspective.

Table 4: Description of Activity 1

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

4.4.1 Summary of HP activities results & recommendations / requirements

As mentioned in Chapter 1, all PJ.02-01-06 Departure concepts have been extensively detailed in the HP Log.

Please refer to the HP Log for Departures, the Issue-Objective-Outcome tabs and Recommendations Register and Requirements Register provide the summary of activities and their results with corresponding evidence, followed by the lists of Recommendations and Requirements, which have been defined in order to mitigate HP risks.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	Activity Conducted	Results / Evidence	Recommendations	Requirements
Arg. 1.1.1: The description of roles & responsibilities cover all affected human actors.							
Arg. 1.1.2: The description of roles & responsibilities cover all tasks to be performed by a human actor.							
Arg. 1.1.3: Roles and responsibilities are clear and consistent (in V1: non-contradictory).							
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.							
Arg. 1.2.2: Operating methods cover operations in abnormal operating conditions.							
Arg. 1.2.3: Operating methods cover degraded modes of the ATM system.							
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).							

Table 5: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

4.4.2 Maturity of the Solution

The V3 Maturity checklist in all HP Logs, Appendix A and Annex A provide details. Criteria of the V3 stage have been fulfilled for the OIs related to the arrival concept.

4.4.2.1 Maturity-V3 WDS-D

Maturity checklist for finalising the V3 assessment (WDS-D)			
ID	Question	Answer	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes	<p>Based on the Change and Argument Identification section, issues have been identified, covering all 4 HP Arguments. For a detailed view on the issues, consult the WDS-D-Issue-Objective-Outcome section of this Excel list.</p> <p>Yes, all arguments have been addressed and supported in the HP Log (please see the WDS-D Issue-Objective-Outcome section of this excel list), with the exception of the Tower supervisor role – this will be addressed in the future stages of the project.</p>
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution	Yes	The assessment of the benefits and issues in terms of human performance was considered to be sufficient at this level of maturity. No further gaps were identified in terms of issues/benefits (with the exception of the Tower supervisor role). Please see the Issue-Benefit-outcome tab in the HP Log for the WDS-D solution scenario

	sufficiently assessed (i.e. on the level required for V3)?		
3	Have all the parts of the solution/concept been considered?	Yes	The parts of solution are considered in the VALP (Sections 3 and 4), OSED and the HP table which is included in the HP Log). The HP Log considers HP benefits and issues, along with the evidence and resulting requirements or recommendations generated for that particular argument, for the WDS-D solution.
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	Interactions were considered with the following projects: Solution PJ.02 (Increased Runway Throughput - Arrivals), PJ.01 (Enhanced Arrivals and Departures).PJ.04 (Total Airport Management), PJ.09 (Advanced Demand & Capacity Balancing), as well as related transversal SESAR Projects (PJ.19 and PJ.22). Also, legacy requirements and recommendations from the CREDOS project have been considered - please see Recommendations register and Requirements Register in the HP Log. However, there were no dependencies identified between the abovementioned projects. In the case of tool development for Arrivals and Departures for PJ.02, to be used within one operation environment, the tool design and HMI principles should be coordinated.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	Validation and subsequent findings outlined in the HPAP have not identified that human performance required for desired system performance exceeded human capabilities. The Issue-Objective-Outcome tab for WDS-D solution in the HP log provides evidence gathered via the relevant activities; All objectives have been met; HP evidence does not reveal major impact on Human Performance. Where outstanding issues have been found, they have been addressed in the Requirements and Recommendations Registers.

6	<p>Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?</p>	Yes	<p>Yes, the concept explored and collected HP evidence in relation to the arguments presented in Section 4.4, which were captured appropriately.</p>
7	<p>Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?</p>	Yes	<p>Overall, the conditions of the Departures RTS were considered to be realistic, based on the ATCO evaluations and debrief session findings. See VALR for further details</p> <p>One non-nominal scenario was explored during the Departures RTS, which was the go-around. During this scenario, a tool issue was encountered, where the tool timer included the incoming flight as a wake separation and therefore jumped ahead to the next aircraft. However, no procedural or HMI change is required as a result. Requirements and Recommendations have been established in order to address degraded modes - suspension of the application of reduced separation.</p>
8	<p>Do validation results confirm that the interactions between human and technology are operationally</p>	No	<p>The specific elements of interaction between humans and technology are addressed in the HP Log (please see the WDS-D section), where the evidence has also assessed that such interactions are deemed operationally feasible, and as consistent with agreed human performance requirements.</p>

	feasible, and consistent with agreed human performance requirements?		<p>The role of the TWR Supervisor in the authorisation of WDS-D remains unaddressed as well as the input of airlines to certain areas of</p> <p>Further research is recommended with regards to the operational and HP benefits of WDS-D; due to the dynamic nature of the concept, planning an effort into the optimisation of the departure sequence might not materialise as the meteorological conditions might change and predictability.</p> <p>As a result, the V3 “on-going” status is more feasible.</p>
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Yes	The findings presented in the HP Log have been reflected in the relevant SESAR documentation for PJ.02-01-06 (e.g. traceability for the SPR-INTEROP Requirements, OSED Part I).
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	<p>Validation outcomes have been considered satisfactory in supporting the presented HP issues and benefits outlined in the HP Log (please see the WDS-D section).</p> <p>- Arguments addressed and associated evidence - All issues/benefits identified within relevant HP argument has been assessed and Requirements or Recommendations assigned</p> <p>Outcomes of HP activities generated a list of Requirements and Recommendations</p>
11	Have HP recommendations and HP	Yes	All HP activities (pre-sim WebEx, documentation research, RTS5, post-simulation workshop) have focused on all 4 high-level HP arguments (Roles, HMI, Teamwork, Transition/Training)

	requirements correctly been considered in HMI design, procedures/documentation and training?		Set of Requirements and Recommendations has been produced
1 2	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	<p>Transition factors as part of the HP Argument structure have been considered and assessed. Relevant training and competency recommendations and requirements have been identified.</p> <p>No impact at organisational level. Impact on TWR controller responsibilities, Supervisor responsibilities are being defined. HMI changes and automation levels are being gauged.</p> <p>For details, see sections of Argument no. 4 in all solution tabs in the HP Logs.</p>

1 3	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.	Yes	No impact at regulation level. Additional and changed responsibilities have been identified and assessed, risks mitigated in the form of Recommendations and Requirements. Please see Arguments 1 and 2 within WDS-D solution concept in the HP Log.
			Please see Arguments 1 and 2 within WDS-D solution concept in the HP Log.
1 4	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	The HP Logs- Recommendation and Requirement registers list all Recommendations and Requirements generated via the HP Assessment activities in V3.
			The role of the TWR Supervisor in the authorisation of WDS-D remains unaddressed as well as the input of airlines to certain areas of HP.
			Further research is recommended with regards to the operational and HP benefits of WDS-D; due to the dynamic nature of the concepts, controller planning an effort into the optimisation of the departure sequence might not materialise as the meteorological conditions might change with little predictability.

4.4.2.2 Maturity-V3 PWS-D

Maturity checklist for finalising the V3 assessment (PWS-D)			
ID	Question	Answer	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes	Based on the Change and Argument Identification section, issues have been identified, covering all 4 HP Arguments. For a detailed view on the issues, consult the PWS-D-Issue-Objective-Outcome section of this Excel list.
			Yes, all arguments have been addressed and supported in the HP Log (please see the PWS-D section), with the exception of the Tower supervisor role – this will be addressed in the future stages of the project.
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	Yes	The assessment of the benefits and issues in terms of human performance was considered to be sufficient at this level of maturity. No further gaps were identified in terms of issues/benefits (with the exception of the Tower supervisor role). Please see the Issue-Benefit-outcome tab in the HP Log for the PWS-D solution scenario
3	Have all the parts of the solution/concept been considered?	Yes	The parts of solution are considered in the VALP (Sections 3 and 4), OSED and the HP table which is included in the HP Log). The HP Log considers PWS-D HP benefits and issues, along with the evidence and resulting requirements or recommendations generated for that particular argument.

4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	Interactions were considered with the following projects: Solution PJ.02 (Increased Runway Throughput - Arrivals), PJ.01 (Enhanced Arrivals and Departures).PJ.04 (Total Airport Management), PJ.09 (Advanced Demand & Capacity Balancing), as well as related transversal SESAR Projects (PJ.19 and PJ.22). Also, legacy requirements and recommendations from the CREDOS project have been considered - please see Recommendations register and Requirements Register in the HP Log. However, there were no dependencies identified between the abovementioned projects. In the case of tool development for Arrivals and Departures for PJ.02, to be used within one operation environment, the tool design and HMI principles should be coordinated.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	Validation and subsequent findings outlined in the HPAP have not identified that human performance required for desired system performance exceeded human capabilities. The Issue-Objective-Outcome tab for PWS-D solution in the HP log provides evidence gathered via the relevant activities; All objectives have been met; HP evidence does not reveal major impact on Human Performance. Where outstanding issues have been found, they have been addressed in the Requirements and Recommendations Registers.
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Yes	Yes, the concept explored and collected HP evidence in relation to the arguments presented in Section 4.4, which were captured appropriately.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions,	Yes	Overall, the conditions of the Departures RTS were considered to be realistic, based on the ATCO evaluations and debrief session findings. See VALR for further details

	including abnormal and degraded conditions?		One non-nominal scenario was explored during the Departures RTS, which was the go-around. During this scenario, a tool issue was encountered, where the tool timer included the incoming flight as a wake separation and therefore jumped ahead to the next aircraft. However, no procedural or HMI change is required as a result. Requirements and Recommendations have been established in order to address degraded modes - suspension of the application of reduced separation.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	The specific elements of interaction between humans and technology are addressed in the HP Log (please see the PWS-D section), where the evidence has also assessed that such interactions are deemed operationally feasible, and as consistent with agreed human performance requirements.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSD, SPR)?	Yes	The findings presented in the HP Log have been reflected in the relevant SESAR documentation for PJ.02-01-06 (e.g. traceability for the SPR-INTEROP Requirements, OSD Part I).
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	<p>Validation outcomes have been considered satisfactory in supporting the presented HP issues and benefits outlined in the HP Log (please see the PWS-D section).</p> <p>- Arguments addressed and associated evidence - All issues/benefits identified within relevant HP argument has been assessed and Requirements or Recommendations assigned</p> <p>Outcomes of HP activities generated a list of Requirements and Recommendations</p>

11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	All HP activities (pre-sim WebEx, documentation research, RTSS, post-simulation workshop) have focused on all 4 high-level HP arguments (Roles, HMI, Teamwork, Transition/Training)
			Set of Requirements and Recommendations has been produced
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	Transition factors as part of the HP Argument structure have been considered and assessed. Relevant training and competency recommendations and requirements have been identified.
			No impact at organisational level. Impact on TWR controller responsibilities, Supervisor responsibilities are being defined. HMI changes and automation levels are being gauged.
			For details, see sections of Argument no. 4 in all solution tabs in the HP Logs.
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.	Yes	No impact at regulation level. Additional and changed responsibilities have been identified and assessed, risks mitigated in the form of Recommendations and Requirements. Please see Arguments 1 and 2 within PWS-D solution concept in the HP Log.
			Please see Arguments 1 and 2 within PWS-D solution concept in the HP Log.
14	Has the next V-phase sufficiently been prepared (additional testing	Yes	The HP Logs- Recommendation and Requirement registers list all Recommendations and Requirements generated via the HP Assessment activities in V3.



	conditions, open HP issues to be addressed)?	The input of airlines to certain areas of HP remains unaddressed.
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4.4.2.3 Maturity-V3 OSD

Maturity checklist for finalising the V3 assessment (OSD 6)			
ID	Question	Answer	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes	Based on the Change and Argument Identification section, issues have been identified, covering all 4 HP Arguments. For a detailed view on the issues, consult the OSD 6-Issue-Objective-Outcome section of this Excel list.
			Yes, all arguments have been addressed and supported in the HP Log (please see the OSD 6 section), with the exception of the Tower supervisor role – this will be addressed in the future stages of the project.
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	Yes	The assessment of the benefits and issues in terms of human performance was considered to be sufficient at this level of maturity. No further gaps were identified in terms of issues/benefits (with the exception of the Tower supervisor role). Please see the Issue-Benefit-outcome tab in the HP Log for OSD 6 solution scenario
3	Have all the parts of the solution/concept been considered?	Yes	The parts of solution are considered in the VALP (Sections 3 and 4), OSED and the HP table which is included in the HP Log). The HP Log considers HP benefits and issues, along with the evidence and resulting requirements or recommendations generated for that particular argument.

4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	Interactions were considered with the following projects: Solution PJ.02 (Increased Runway Throughput - Arrivals), PJ.01 (Enhanced Arrivals and Departures).PJ.04 (Total Airport Management), PJ.09 (Advanced Demand & Capacity Balancing), as well as related transversal SESAR Projects (PJ.19 and PJ.22). Also, legacy requirements and recommendations from the CREDOS project have been considered - please see Recommendations register and Requirements Register in the HP Log. However, there were no dependencies identified between the abovementioned projects. In the case of tool development for Arrivals and Departures for PJ.02, to be used within one operation environment, the tool design and HMI principles should be coordinated.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	Validation and subsequent findings outlined in the HPAP have not identified that human performance required for desired system performance exceeded human capabilities. The Issue-Objective-Outcome tab for OSD 6 solution in the HP log provides evidence gathered via the relevant activities; All objectives have been met; HP evidence does not reveal major impact on Human Performance. Where outstanding issues have been found, they have been addressed in the Requirements and Recommendations Registers.
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Yes	Yes, the concept explored and collected HP evidence in relation to the arguments presented in Section 4.4, which were captured appropriately.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions,	Yes	Overall, the conditions of the Departures RTS were considered to be realistic, based on the ATCO evaluations and debrief session findings. See VALR for further details

	including abnormal and degraded conditions?		One non-nominal scenario was explored during the Departures RTS, which was the go-around. During this scenario, a tool issue was encountered, where the tool timer included the incoming flight as a wake separation and therefore jumped ahead to the next aircraft. However, no procedural or HMI change is required as a result. Requirements and Recommendations have been established in order to address degraded modes - suspension of the application of reduced separation.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	The specific elements of interaction between humans and technology are addressed in the HP Log (please see the OSD 6 section), where the evidence has also assessed that such interactions are deemed operationally feasible, and as consistent with agreed human performance requirements.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSD, SPR)?	Yes	The findings presented in the HP Log have been reflected in the relevant SESAR documentation for PJ.02-01-06 (e.g. traceability for the SPR-INTEROP Requirements, OSD Part I).
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	<p>Validation outcomes have been considered satisfactory in supporting the presented HP issues and benefits outlined in the HP Log (please see the OSD 6 section).</p> <p>- Arguments addressed and associated evidence - All issues/benefits identified within relevant HP argument has been assessed and Requirements or Recommendations assigned</p> <p>Outcomes of HP activities generated a list of Requirements and Recommendations</p>

11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	All HP activities (pre-sim WebEx, documentation research, RTS5, post-simulation workshop) have focused on all 4 high-level HP arguments (Roles, HMI, Teamwork, Transition/Training) Set of Requirements and Recommendations has been produced
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	Transition factors as part of the HP Argument structure have been considered and assessed. Relevant training and competency recommendations and requirements have been identified. No impact at organisational level. Impact on TWR controller responsibilities, Supervisor responsibilities are being defined. HMI changes and automation levels are being gauged. For details, see sections of Argument no. 4 in OSD 6 solution tab in the HP Log.
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.	Yes	No impact at regulation level. Additional and changed responsibilities have been identified and assessed, risks mitigated in the form of Recommendations and Requirements. Please see Arguments 1 and 2 within OSD 6 solution concept in the HP Log. Please see Arguments 1 and 2 within OSD 6 solution concept in the HP Log.
14	Has the next V-phase sufficiently been prepared (additional testing	Yes	The HP Logs- Recommendation and Requirement registers list all Recommendations and Requirements generated via the HP Assessment activities in V3.



	conditions, open HP issues to be addressed)?	The input of airlines to certain areas of HP remains unaddressed.
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5 References

Human Performance

- [1] SESAR Human Performance Assessment Process V1 to V3 (including VLDs)
- [2] 16.04.01 Evolution from the ATM HF case to a HP Case Methodology for SESAR, HP assessment process for projects in V1, V2 or V3. D10-001, 00.01.00
- [3] 06.09.03 D05.1 Single Remote Tower Validation Plan – Appendix Human Performance Assessment Plan
- [4] 16.06.05 D 27 HP Reference Material D27
- [5] 16.04.02 D04 e-HP Repository - Release note
- [6] Bretigny partner workshop minutes October 2018, Eurocontrol
- [7] SESAR 2020 PJ.02-01-06 VALR (V3)

Appendix A – Additional HP activities conducted

This section contains the outputs from the HP activities conducted for the Solution.



Minutes for PJ02-01
Departure Concepts

Appendix B – HP Recommendations Register

The Recommendations Register addresses the recommendations generated from the NATS and ENAIRE Departures RTS exercises. The relevant recommendations can be found in the embedded HP Log for Departures in Appendix D.2.

Appendix C – HP Requirements Register

The Requirements Register addresses the requirements generated from the NATS and ENAIRE Departures RTS exercises and other activities. The relevant requirements can be found in the embedded HP Log in Appendix D.2.

Appendix D– HP Log

This section contains HP Logs for the PJ.02-01 Solutions plus the updated HP Log for Solution PJ02-01-06 based on the flight simulation conducted in SESAR 2020 Wave 2..



HP Log
PJ02-01-06_updated_

