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SESAR Solution PJ.02-01-04 SPR-INTEROP/OSED for V2 - Part IV - Human Performance Assessment Report

DeliverableID	D4.15.002
Dissemination Level:	PU
ProjectAcronym	PJ.02-W2 AART
Grant:	874477
Call:	H2020-SESAR-2019-1
Topic:	Airport, Airside and Runway Throughput
Consortium coordinator:	EUROCONTROL
Edition date:	19th October 2022
Edition:	00.01.00
Template Edition	02.00.05

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AIRBUS	30/11/2019
NATS	30/11/2019
EUROCONTROL	30/09/2022

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Beneficiary	Date
EUROCONTROL	10/10/2022
NATS	17/10/2022
HAL	02/11/2022

Reviewers external to the project

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Beneficiary	Date
EUROCONTROL	19/10/2022
NATS	19/10/2022
HAL	02/11/2022

Rejected By - Representatives of beneficiaries involved in the project

Beneficiary	Date

Document History

Edition	Date	Status	Beneficiary	Justification
00.00.01	05/11/2020	Draft	EUROCONTROL	Initial draft of the document
00.00.02	30/09/2022	Final	EUROCONTROL	Final version for partner review
00.01.00	19/10/2022	Final	EUROCONTROL	Final version for submission

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Copyright Statement

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.02-01-04 (WTS (for Arrivals) 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-A, PWS-A and ORD) 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:

- 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

These activities were focused on the identification of Human Performance-related hazards and benefits associated with all concepts. Evidence was gathered via qualitative and quantitative methods using subjective and objective data-capture.

The criteria of the V3 Maturity assessment have been met. As no PJ.02-01-04 validation activities were conducted in SESAR 2020 Wave 2 for Human Performance, the content of this document has not changed since SESAR 2020 Wave 1.

Table of Contents

List of Tables

List of Figures

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1 Executive Summary

This document contains the Human Performance Assessment for the application of the SESAR Solution PJ.02-01-04 (WTS (for Arrivals) 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.02-01-04 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.02-01-04 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 no PJ.02-01-04 validation activities were conducted in SESAR 2020 Wave 2 for Human Performance, the content of this document has not changed since SESAR 2020 Wave 1.

This Human Performance Assessment Report aggregates the main Solution scenarios of the SESAR Solution PJ.02-01-04 as follows:

- Static Pairwise Separations (S-PWS) - Wake turbulence separations for arrivals based on static aircraft characteristics (AO-0306);
- Weather Dependent Separations (WDS) - weather dependant reductions of wake turbulence separations on the final approach (AO-0310);
- Optimised Runway Delivery (ORD) - a controller tool to support the application of static pairwise separations and weather dependent separations on the final approach (AO-0328).

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.**

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The validation activities performed encompassing a task analysis review, prototyping sessions, real time simulations and workshops have thoroughly addressed the HP issues formulated as part of the Human Performance Assessment Plan, covering the 4 level HP Arguments. As a result, all HP issues/ benefits formulated for the three arrivals related OIs have been clarified and closed and all three OIs have been identified as reaching a V3 maturity level.

No negative impact of the solution scenarios proposed was identified compared to the reference scenarios. A clear benefit of the ORD concept was identified with respect to controller mental workload, time management, team situational awareness and task organisation. For an in depth understanding of the findings of the validation activities, please refer to the HP Log comprising the list of HP activities conducted and the corresponding requirements and recommendations. These are accompanied by a rationale- explaining the reason behind the formulation of the requirements and recommendations. The PJ.02-01-04 VALR [7] and the workshop notes (Appendix A) should be consulted in order to have a full picture of the validation activities conducted.

The HP Log for Arrivals [Appendix D.1] assesses separately all three OIs related to the arrival concept:

- WDS-A- (AO-0310);
- PWS-A- (AO-0306);
- ORD- (AO-0328).

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

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.02-01-04 WTS (for Arrivals) based on Static Aircraft Characteristics in the frame of SESAR 2020 including requirements and recommendations.

The SESAR Solution PJ.02-01-04 design and validation work is organized according to five main threads, defined via the following operational scenarios:

EUROCONTROL Thread

- RTS1: WDS-A with ORD for Arrivals, on single Runway (RWY) in segregated mode, for Paris CDG airport (encompassing transition from/to Distance or Time Based (DBS or TBS) standard separations);
- RTS3a: PWS-A with ORD for Arrivals, and PWS-D with OSD for Departures, on single RWY in mixed mode, for Vienna airport;
- RTS3b: PWS-A with ORD for Arrivals, on single RWY segregated, for Copenhagen 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.

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 arrivals concepts solutions consist of Wake Turbulence Separations for Arrivals based on the static characteristics of the arriving aircraft (Static Pairwise Separations - PWS-A -AO-0306) and time-based weather dependent separations based on the cross-wind concept (WDS-A- AO-0310), using the ORD tool (AO-0328).

The ORD concept and in particular the Separation Delivery tool supports the Controllers in delivering the required separation or spacing on final approach to the runway landing threshold. The Separation Delivery tool calculates and displays Target Distance Indicators (TDIs) on the Approach and Tower CWPs. The TDIs include an FTD indicator which displays the required separation / spacing to be delivered to the required delivery point and an Initial Target Distance (ITD) indicator which displays the required spacing to deliver at the DF to support the Controller in delivering the required separation / spacing.

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All details about the functionalities of the ORD tool can be found in chapter 3.3.2.1.1 of the OSED:

- Approach Arrivals Sequence Input
- Separation and Spacing (WT Separation; Managing compression on Final APP; MRS; ROT)
- Wind Input
- Additional Tool Inputs (e.g. call signs, a/c type)
- Final Target Distance
- Initial Target Distance
- Indicator Support and Turn-on Support
- Modes of Operation (e.g. DBS with ORD; S-PWS with ORD & WDS with ORD)
- Monitoring and Alerting
- Controller Procedures for ORD
- Airspace Users Procedures for ORD
- Coordination between TWR and APP ATC for Transition between Modes of Operations
- Transition to Degraded mode
- ORD in Mixed mode operations
- Insertion of Gap

2.1.1 PWS-A

PWS-A (AO-0306) is the efficient aircraft type pairwise wake separation rules for final approach consisting of both the 96 x 96 aircraft type based pairwise wake separation minima and the 20-CAT wake category-based wake separation minima for arrival pairs involving other aircraft types. The PWS-A concept proposes wake separation minima based on the aircraft type of the lead and follower aircraft on the final approach, as opposed to the wake vortex category.

2.1.2 WDS-A

The WDS-A concept (AO-0310) proposes to relax or reduce separation as a function of the total wind or crosswind component. 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. As WDS are applicable to wake separations then benefit would be seen at airports with at least 5/10% Heavy traffic, the same as for S-PWS.

2.1.3 ORD concept

As the separations under S-PWS and WDS for arrivals will be reduced compared to current operations and also vary as a function of the aircraft type of the lead and follower aircraft and / or the wind respectively, controllers will require a tool to support the application of these new separation schemes. ORD consists of a controller tool to support the application of PWS-A and WDS-A concepts. The ORD tool will enable consistent and efficient delivery of the required separation or spacing between arrival pairs whatever separation scheme

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;

HP practitioners at the level of the transversal areas and federating projects are also expected to have an interest in this document.

Other stakeholders that may be interested in this document are to be found among:

- NATS Employee unions
- NATS Swanwick Control Centre
- Heathrow Airport Limited (HAL)
- Airspace users/Airlines

Furthermore, the intended readership is the SESAR Solution PJ.02-01-04 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.

2.1 Human performance work schedule within the Solution

The Human Performance Assessment for the PJ.02-01-04 Solution was conducted according to the PJ.02-01-04 Validation Plan and Human Performance Assessment Plan.

Human Performance activities started in 2017 and finished in Summer2019, for Wave 1. For a full detailed on the prototyping sessions and real time simulations findings, please refer to the PJ.02-01-04 VALR [7].

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 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

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Post-Simulation Workshop – internal	21 March 2019	NATS CTC
Post-Simulation Workshop with external participants	28 March 2019	Heathrow Airport

2.2 Structure of the document

This section describes the content of the different chapters

The Part IV - HPAR of the SESAR Solution PJ.02-01-04 SPR-INTEROP/OSED consists of four main sections and four appendices. Each section, and appendix, addresses each of the SESAR Solution PJ.02-01-04 WTS (for Arrivals) 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.

2.3 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

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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

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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, 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.

Table 1: Acronyms and terminology

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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.

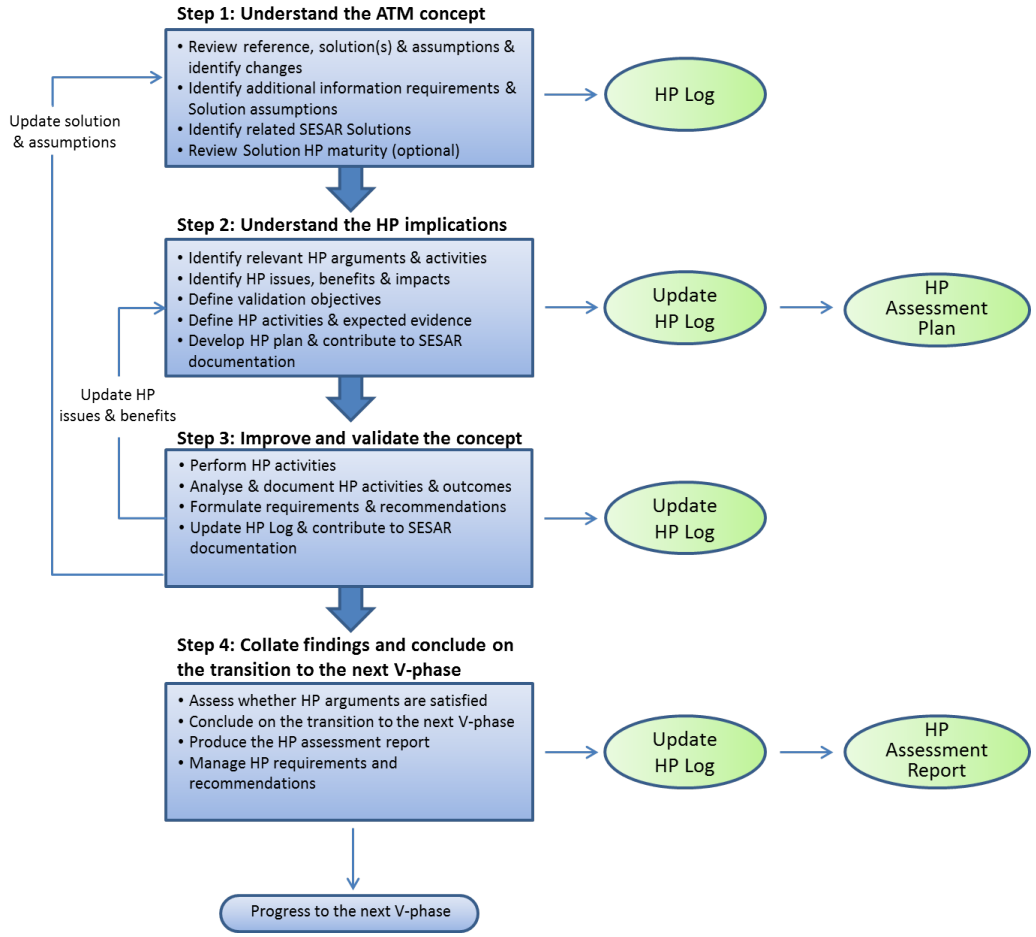

Figure 1: Steps of the HP assessment process

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

The HP Material presented below focuses on Arrivals primarily however includes possible departures; hence the assessment entails Mixed-mode operations.

4.1.1 Description of reference scenario

The description of the reference scenario can be found in the Arrivals HP Log (Solution & Concept Info tab) (Appendix D.1).

4.1.2 Description of solution scenario

The description of the solution scenario can be found in the Arrivals HP Log (Solution & Concept Info tab).

4.1.3 Consolidated list of assumptions

The consolidated list of assumptions can be found in the Arrivals HP Log (Solution & Concept Info tab).

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

The description of the related SESAR solutions can be found in the Arrivals HP Log (Solution & Concept Info tab).

4.1.5 Identification of the nature of the change

The description of the nature of change can be found in the Arrivals HP Log (WDS-A/PWS-A 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 Arrivals HP Log (Issue-Objective Outcome tabs for solutions).

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4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

This section forms the actual HP plan of activities. It outlines the HP activities that have been selected on the basis of the relevant arguments and HP issues and benefits. Table 3 below contains the overview of these activities and their priority together with deadlines which are in line with the other solution deliverables.

HP activity	By when
Task Analysis	June 2019
Stakeholder Workshop	June 2019
Prototyping Session	June 2019
Real Time Simulation	June 2019

Table 3: Table of proposed HP activities and their priority

Table 4 and 5 (Activity 1 and 2) have been left blank intentionally.

For a detailed view on the planned activities, please read the "Issue-Objective-Outcome" in the corresponding HP Logs, [Appendix A]: HP log for Arrivals- for WDS-A and PWS-A; HP Log for Departures for WDS-D, PWS-D; and HP Log for Wake Monitoring, in Annex A.

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.02-01-04 Arrival concepts have been extensively detailed in the HP Log.

Please refer to the HP Log for Arrivals, 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.

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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 2: 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 thee OIs related to the arrival concept.

4.4.2.1 Maturity-V3 WDS-A

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	Based on the Change and Argument Identification section, 167 issues have been identified, covering all 4 HP Arguments. For a detailed view on the issues, consult the WDS-A-Issue-Objective-Outcome section of this Excel list. All 4 high-level HP Arguments have been covered. 2nd level HP Arguments covered: - Argument 1.1.Roles and Responsibilities - Argument 1.2. Operating Methods - Argument 1.3. Tasks - Argument 2.1 Allocation of tasks (between the human and the machine) - Argument 2.2. Performance of the technical systems - Argument 2.3. Human-machine interface - Argument 3.2. Allocation of tasks (between human actors) - Argument 3.3. Communication - Argument 4.1. Acceptance and job satisfaction - Argument 4.2. Competence requirements - Argument 4.5. Training Based on the validation activities (task analysis, prototyping sessions, RTS - EXE.PJ02.01-

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			VALP-RTS1 and workshops) all aforementioned arguments have been properly addressed in relation to the expected evidence for a V3 maturity level. The outcomes of the validation activities are documented in the Recommendation and Requirement registers (as part of this Excel document) where all requirements and recommendations are accompanied by a rationale that details the reasons behind them. As soon as the findings of any of the aforementioned validation activities were considered relevant in answering any of the arguments addressed, they have been formulated in recommendations and requirements, ensuring the information is properly documented. In the
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	All issues/benefits have been thoroughly assessed in the validation activities and as soon as the evidence expected for the V3 maturity level have been met, the corresponding issues/benefits have been closed. The assessment has always included the participation of operational experts either through validation exercises or through workshop activities. See question 1 above and the WDS-A-Issue-Objective-Outcome section of the Excel list for a detailed view on the formulated issues corresponding to all 4 Arguments. Detailed in the WDS-A-Issue-Objective-Outcome section of the Excel document. All Outcomes have been detailed in the Recommendations and Requirements Registers where in addition; the rationale columns offer a more in-depth explanation on the findings.
3	Have all the parts of the solution/concept been considered?	Yes	All parts of the solution/concept have been considered, on the basis of the change and argument identification step- which represented the starting point of the HP activities. For a detailed description of the solution/concept and related assumptions, please refer to the "Solution and Concept Info" sheet of this Excel document, where all arrival related OIs have been documented.

			For the list of assumptions that have a link with the HP activities, please refer to the “Solution and Concept Info" sheet of this Excel document The detailed list of issues/benefits and associated validation objectives for WDS-A is to be found in the "WDS-A-Issue-Objective-Outcome" sheet of this Excel document.
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	The list of the related projects/solutions has been identified - as documented in the OSED and the HP Plan- Part IV of the VALP. List of related projects: • SESAR Project PJ.02 Increased Runway and Airport Throughput • SESAR Project PJ.01 Enhanced Arrivals and Departures • SESAR Project PJ.04 Total Airport Management • SESAR Project PJ.09 Advanced Demand & Capacity Balancing • Related transversal SESAR Projects PJ.19 and PJ.22 E.g. sequencing tool - AMAN/DMAN (PJ.02-08). Validation activities of PJ02.01 have been merged with PJ.02-02 and PJ.02-03 validation activities and all potential interactions have been documents, if any. With PJ.02-08 a potential interaction has been identified with regard to the sequencing tool and the use of the AMAN/DMAN- no common activities have been performed. For PJ.04 and PJ.09 no common HP activities have been performed.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human	Yes	The level of human performance needed to achieve the desired system performance has been assessed and confirmed as consistent with human capabilities. Detailed in Arg. 1 and Arg. 2

	capabilities?		
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Yes	Please check the "WDS-A-Issue-Objective-Outcome" section for a detailed view on the assessment methodology envisaged for PJ.02-01-06- WDS-A concept. The results obtained from an HP perspective are in line with the proposed targets as all HP related validation objectives have been successfully covered.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Yes	The validation activities were built and conformed to experimental design principles, ensuring realistic conditions, and allowing the participants to get sufficiently familiar with the new concept through various training sessions and prototyping sessions before the real time simulation was conducted. For all the issues that were not fully covered during RTS due to simulation limitations, the workshop discussions have ensured an in-depth coverage of the remaining open issues that have been closed based on "expert judgement" of both operational experts and HP experts. The validation activities were built based on the relevant information from SESAR 1, ensuring a transversal approach (HP, safety, validation, and operational experts) in validation activities- prototyping sessions and RTS.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	The validation results confirm that the interactions between human and technology are operationally feasible and consistent with agreed HP requirements. For a detailed view on the identified issues and the results of the validations, please consult all sections related to WDS-A in the current Excel document.
9	Have all relevant SESAR documentation been updated	Yes	Following the identification of HP issues and benefits, all 4 high level HP Arguments have been included in the VALP, ensuring the success criteria fully covers HP needs.

	according to the HP activities outcomes (OSED, SPR)?		Consequently the VALR embedded the HP report made following the real time simulation that has documented HP findings in relation to the validation objectives. Once the list of recommendations and requirements has been finalised from an HP perspective, they have been checked against the safety requirements and commonly agreed with the OSED leader, Validation expert and Safety expert and they have been included in part I of the OSED - categorised as HP requirements. It has been commonly agreed that the "should" requirements or the recommendations will not be included in Part I of the OSED as they are not "mandatory" for implementation and hence the reader should consult the current HP Log/HP report for all the identified HP recommendations.
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document. For the identified Arguments, please refer to the "WDS-A-Issue-Objective-Outcome" section. For the identified Issues/Benefits please refer to the "WDS-A-Issue-Objective-Outcome" section. The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	The requirements formulated based on the HP activities have been documented in part I of the OSED. The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document.

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	Please refer to Arg. 4 -issues/benefits in the "WDS-A-Issue-Objective-Outcome" section of the Excel document and correspondingly in the Recommendations and Requirements sections. Argument 2 and Argument 4 have covered issues/benefits with regard to the task allocation human-machine and impacts on the organisational level Please check the Recommendation and Requirements section for the outcome of the HP activities.
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	Please refer to Arg. 1 and Arg. 2 for corresponding issues and benefits identified in the "WDS-A-Issue-Objective-Outcome" section of the Excel document. All related recommendations and requirements relevant to changes in roles & responsibilities, competence requirements, or the task allocation between human & machine, are to be found in the Recommendations and Requirements sections.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	Please refer to the "WDS-A-Issue-Objective-Outcome" section of the Excel document. All identified issues and benefits have been closed for WDS-A. The requirements formulated based on the HP activities have been documented in part I of the OSED.

4.4.2.2 Maturity-V3 PWS-A

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	Based on the Change and Argument Identification section, 120 issues have been identified, covering all 4 HP Arguments for PWS-A-segregated mode. For a detailed view on the issues, consult the PWS-A-Issue-Objective-Outcome section of this Excel list. All 4 high-level HP Arguments have been covered. 2nd level HP Arguments covered: - Argument 1.1.Roles and Responsibilities - Argument 1.2. Operating Methods - Argument 1.3. Tasks - Argument 2.1 Allocation of tasks (between the human and the machine) - Argument 2.2. Performance of the technical systems - Argument 2.3. Human-machine interface - Argument 3.3. Communication - Argument 4.1. Acceptance and job satisfaction - Argument 4.2. Competence requirements - Argument 4.5. Training Based on the validation activities (task analysis, prototyping sessions, RTS and workshops) all aforementioned arguments have been properly addressed in relation to the expected evidence for a V3 maturity level. RTS: - EXE.PJ.02-01-06-VALP-RTS2

			- EXE.PJ.02-01-06-VALP-RTS3a - EXE.PJ.02-01-06-VALP-RTS4a - EXE.PJ.02-01-06-VALP-RTS4b The outcomes of the validation activities are documented in the Recommendation and Requirement registers (as part of this Excel document) where all requirements and recommendations are accompanied by a rationale that details the reasons behind them. As soon as the findings of any of the aforementioned validation activities were considered relevant in answering any of the arguments addressed, they have been formulated in recommendations and requirements, ensuring the information is properly documented. In the
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	All issues/benefits related to PWS-A (segregated mode) have been thoroughly assessed in the validation activities and as soon as the evidence expected for the V3 maturity level have been met, the corresponding issues/benefits have been closed. The assessment has always included the participation of operational experts either through validation exercises or through workshop activities. See question 1 above and the PWS-A-Issue-Objective-Outcome section of the Excel list for a detailed view on the formulated issues corresponding to all 4 Arguments. Detailed in the PWS-A-Issue-Objective-Outcome section of the Excel document. All Outcomes have been detailed in the Recommendations and Requirements Registers where in addition; the rationale columns offer a more in depth explanation on the findings.
3	Have all the parts of the solution/concept been considered?	Yes	All parts of the solution/concept have been considered, on the basis of the change and argument identification step- which represented the starting point of the HP activities. For a detailed description of the solution/concept and related assumptions, please refer to the "Solution and Concept Info" sheet of this Excel document, where all arrival related

			OIs have been documented. For the list of assumptions that have a link with the HP activities, please refer to the “Solution and Concept Info" sheet of this Excel document The detailed list of issues/benefits and associated validation objectives for PWS-A is to be found in the "PWS-A-Issue-Objective-Outcome" sheet of this Excel document.
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	The list of the related projects/solutions has been identified - as documented in the OSED and the HP Plan- Part IV of the VALP. List of related projects: • SESAR Project PJ.02 Increased Runway and Airport Throughput • SESAR Project PJ.01 Enhanced Arrivals and Departures • SESAR Project PJ.04 Total Airport Management • SESAR Project PJ.09 Advanced Demand & Capacity Balancing • Related transversal SESAR Projects PJ.19 and PJ.22 E.g. sequencing tool - AMAN/DMAN (PJ.02-08). Validation activities of PJ.02-01-04 have been merged with PJ.02-02 and PJ.02-03 validation activities and all potential interactions have been documents, if any. With PJ.02-08 a potential interaction has been identified with regard to the sequencing tool and the use of the AMAN/DMAN- no common activities have been performed. For PJ.04 and PJ.09 no common HP activities have been performed.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human	Yes	The level of human performance needed to achieve the desired system performance has been assessed and confirmed as consistent with human capabilities. Detailed in Arg. 1 and Arg. 2

	capabilities?		
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Yes	Please check the "PWS-A-Issue-Objective-Outcome" section for a detailed view on the assessment methodology envisaged for PJ.02-01-06- PWS-A concept (segregated mode). The results obtained from an HP perspective are in line with the proposed targets as all HP related validation objectives have been successfully covered.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Yes	The validation activities were built and conformed to experimental design principles, ensuring realistic conditions and allowing the participants to get sufficiently familiar with the new concept through various training sessions and prototyping sessions before the real time simulation was conducted. For all the issues that were not fully covered during RTS due to simulation limitations, the workshop discussions have ensured an in depth coverage of the remaining open issues that have been closed based on "expert judgement" of both operational experts and HP experts. The validation activities were built based on the relevant information from SESAR 1, ensuring a transversal approach (HP, safety, validation and operational experts) in validation activities- prototyping sessions and RTS.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	The validation results confirm that the interactions between human and technology are operationally feasible and consistent with agreed HP requirements. For a detailed view on the identified issues and the results of the validations, please consult all sections related to PWS-A in the current Excel document.
9	Have all relevant SESAR documentation been updated according to the HP activities	Yes	Following the identification of HP issues and benefits, all 4 high level HP Arguments have been included in the VALP, ensuring the success criteria fully covers HP needs. Consequently the VALR embedded the HP report made following the real time simulation that has documented HP findings in relation to the validation objectives. Once the list of

	outcomes (OSED, SPR)?		recommendations and requirements has been finalised from an HP perspective, they have been checked against the safety requirements and commonly agreed with the OSED leader, Validation expert and Safety expert and they have been included in part I of the OSED - categorised as HP requirements. It has been commonly agreed that the "should" requirements or the recommendations will not be included in Part I of the OSED as they are not "mandatory" for implementation and hence the reader should consult the current HP Log/HP report for all the identified HP recommendations.
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document. For the identified Arguments, please refer to the "PWS-A-Issue-Objective-Outcome" section. For the identified Issues/Benefits please refer to the "PWS-A-Issue-Objective-Outcome" section. The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	The requirements formulated based on the HP activities have been documented in part I of the OSED. The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document.
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing	Yes	Please refer to Arg. 4 -issues/benefits in the "PWS-A-Issue-Objective-Outcome" section of the Excel document and correspondingly in the Recommendations and Requirements sections. Argument 2 and Argument 4 have covered issues/benefits with regard to the task

	requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?		allocation human-machine and impacts on the organisational level Please check the Recommendation and Requirements section for the outcome of the HP activities.
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	Please refer to Arg. 1 and Arg. 2 for corresponding issues and benefits identified in the "PWS-A-Issue-Objective-Outcome" section of the Excel document. All related recommendations and requirements relevant to changes in roles & responsibilities, competence requirements, or the task allocation between human & machine, are to be found in the Recommendations and Requirements sections.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	Please refer to the "PWS-A-Issue-Objective-Outcome" section of the Excel document. All identified issues and benefits have been closed for PWS-A. The requirements formulated based on the HP activities have been documented in part I of the OSED.

4.4.2.3 Maturity-V3 ORD

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	146 issues related to the use of the ORD tool have been identified, following the evaluation of the change assessment for WDS-A and PWS-A, where the use of the ORD tool was included as well in the validation activities in addition to the reduced separations proposed. The purpose of the HP assessment was to validate the ORD concept in segregated mode, mixed mode and CSPR operations. For a detailed view on the issues, consult the ORD-Issue-Objective-Outcome section of this Excel list. All 4 high-level HP Arguments have been covered. 2nd level HP Arguments covered: - Argument 1.1.Roles and Responsibilities - Argument 1.2. Operating Methods - Argument 1.3. Tasks - Argument 2.1 Allocation of tasks (between the human and the machine) - Argument 2.2. Performance of the technical systems - Argument 2.3. Human-machine interface - Argument 3.2. Allocation of tasks (between human actors) - Argument 3.3. Communication - Argument 4.1. Acceptance and job satisfaction - Argument 4.2. Competence requirements

			- Argument 4.5. Training Based on the validation activities (task analysis, prototyping sessions, RTS and workshops) all aforementioned arguments have been properly addressed in relation to the expected evidence for a V3 maturity level. RTS: - EXE-PJ.02-01-06-VALP-RTS1: - EXE.PJ.02-01-06-VALP-RTS2 - EXE.PJ.02-01-06-VALP-RTS3a - EXE.PJ.02-01-06-VALP-RTS4a - EXE.PJ.02-01-06-VALP-RTS4b The outcomes of the validation activities are documented in the Recommendation and Requirement registers (as part of this Excel document) where all requirements and recommendations are accompanied by a rationale that details the reasons behind them. As soon as the findings of any of the aforementioned validation activities were considered relevant in answering any of the arguments addressed, they have been formulated in recommendations and requirements, ensuring the information is properly documented. In the
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	All issues/benefits related to PWS-A (segregated mode) have been thoroughly assessed in the validation activities and as soon as the evidence expected for the V3 maturity level have been met, the corresponding issues/benefits have been closed. The assessment has always included the participation of operational experts either through validation exercises or through workshop activities. See question 1 above and the PWS-A-Issue-Objective-Outcome section of the Excel list for a detailed view on the formulated issues corresponding to all 4 Arguments. Detailed in the PWS-A-Issue-Objective-Outcome section of the Excel document.

			All Outcomes have been detailed in the Recommendations and Requirements Registers where in addition; the rationale columns offer a more in depth explanation on the findings.
3	Have all the parts of the solution/concept been considered?	Yes	All parts of the solution/concept have been considered (ORD in segregated/ mixed mode and CSPR operations). For a detailed description of the solution/concept and related assumptions, please refer to the OSED. For the list of assumptions that have a link with the HP activities, please refer to the “Solution and Concept Info" sheet of this Excel document The detailed list of issues/benefits and associated validation objectives for ORD is to be found in the "ORD-Issue-Objective-Outcome" sheet of this Excel document.
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	The list of the related projects/solutions has been identified - as documented in the OSED and the HP Plan- Part IV of the VALP. List of related projects: • SESAR Project PJ.02 Increased Runway and Airport Throughput • SESAR Project PJ.01 Enhanced Arrivals and Departures • SESAR Project PJ.04 Total Airport Management • SESAR Project PJ.09 Advanced Demand & Capacity Balancing • Related transversal SESAR Projects PJ.19 and PJ.22 E.g. sequencing tool - AMAN/DMAN (PJ.02-08). Validation activities of PJ.02-01-04 have been merged with PJ.02-02 and PJ.02-03 validation activities and all potential interactions have been documents, if any. With PJ.02-08 a potential interaction has been identified with regard to the sequencing tool

			and the use of the AMAN/DMAN- no common activities have been performed. For PJ.04 and PJ.09 no common HP activities have been performed.
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	The level of human performance needed to achieve the desired system performance has been assessed and confirmed as consistent with human capabilities. Detailed in Arg. 1 and Arg. 2
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	Please check the "ORD-Issue-Objective-Outcome" section for a detailed view on the assessment methodology envisaged for validating the ORD concept in segregated mode, mixed mode and CSPR operations. The results obtained from an HP perspective are in line with the proposed targets as all HP related validation objectives have been successfully covered.
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Yes	The validation activities were built and conformed to experimental design principles, ensuring realistic conditions and allowing the participants to get sufficiently familiar with the new concept through various training sessions and prototyping sessions before the real time simulation was conducted. For all the issues that were not fully covered during RTS due to simulation limitations, the workshop discussions have ensured an in depth coverage of the remaining open issues that have been closed based on "expert judgement" of both operational experts and HP experts. The validation activities were built based on the relevant information from SESAR 1, ensuring a transversal approach (HP, safety, validation and operational experts) in validation activities- prototyping sessions and RTS.

8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	The validation results confirm that the interactions between human and technology are operationally feasible and consistent with agreed HP requirements. For a detailed view on the identified issues and the results of the validations, please consult all sections related to ORD in the current Excel document.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Yes	Following the identification of HP issues and benefits, all 4 high level HP Arguments have been included in the VALP, ensuring the success criteria fully covers HP needs. Consequently the VALR embedded the HP report made following the real time simulation that has documented HP findings in relation to the validation objectives. Once the list of recommendations and requirements has been finalised from an HP perspective, they have been checked against the safety requirements and commonly agreed with the OSED leader, Validation expert and Safety expert and they have been included in part I of the OSED - categorised as HP requirements. It has been commonly agreed that the "should" requirements or the recommendations will not be included in Part I of the OSED as they are not "mandatory" for implementation and hence the reader should consult the current HP Log/HP report for all the identified HP recommendations.
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document. For the identified Arguments, please refer to the "ORD-Issue-Objective-Outcome" section. For the identified Issues/Benefits please refer to the "ORD-Issue-Objective-Outcome" section. The outcome of the HP activities is to be found in the Recommendations and

			Requirements register sections of this Excel document.
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	The requirements formulated based on the HP activities have been documented in part I of the OSED. The outcome of the HP activities is to be found in the Recommendations and Requirements register sections of this Excel document.
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	Please refer to Arg. 4 -issues/benefits in the "ORD-Issue-Objective-Outcome" section of the Excel document and correspondingly in the Recommendations and Requirements sections. Argument 2 and Argument 4 have covered issues/benefits with regard to the task allocation human-machine and impacts on the organisational level Please check the Recommendation and Requirements section for the outcome of the HP activities.
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	Please refer to Arg. 1 and Arg. 2 for corresponding issues and benefits identified in the "ORD-Issue-Objective-Outcome" section of the Excel document. All related recommendations and requirements relevant to changes in roles & responsibilities, competence requirements, or the task allocation between human & machine, are to be found in the Recommendations and Requirements sections.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP	Yes	Please refer to the "ORD-Issue-Objective-Outcome" section of the Excel document. All identified issues and benefits have been closed for the ORD concept.

	issues to be addressed)?		The requirements formulated based on the HP activities have been documented in part I of the OSED.

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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.02-01-04 VALR (V3)

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Appendix A – Additional HP activities conducted

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


Workshop 1 PJ02-01 and Pj02-03.


Workshop Pj02 questions pilots anc

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Appendix B – HP Recommendations Register

The Recommendations Register addresses the recommendations generated from the EUROCONTROL and ENAIRE Arrivals RTS exercises. The relevant recommendations can be found in the embedded HP Log "*HP LOG PJ02_01 Arrivals ECTL and ENAIRE Consolidated Final*" in Appendix D.1.

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Appendix C – HP Requirements Register

The Requirements Register addresses the requirements generated from the EUROCONTROL and ENAIRE Arrivals RTS exercises. The relevant requirements can be found in the embedded HP Log "*HP LOG PJ02_01 Arrivals ECTL and ENAIRE Consolidated Final*" in Appendix D.1.

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Appendix D– HP Log

This section contains HP Logs for the PJ.02-01-04 Solutions.

The combined EUROCONTROL and ENAIRE HP Log is embedded below.

Final Log HPAR Arrivals.xlsx

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