

SESAR Solution PJ05.97.1 and 97.2 TS/IRS TRL4 - Part IV - Human Performance Assessment Report

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DTT

DIGITAL TECHNOLOGIES FOR TWR

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Abstract

This document contains the Human Performance (HP) assessment report for the PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower and PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning, which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements. It corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step4 – Collate findings & conclude on transition to next TRL6-phase.

A set of requirements and recommendations have been identified based on the collected results and need to be validated in next TRL6 phase.

The HP collected results shows that both the technologies have achieved TRL4 for HP maturity and are ready for next TRL6 phase.

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1 Executive Summary

This document describes the results of the activities conducted to date according to the Human Performance assessment process to derive the Human Performance Report for the Solutions PJ05.97.1 and 97.2, “Virtual/augmented reality applications for Tower” and “ASR at the TWR CWP supported by AI and Machine Learning” respectively.

It is based on PJ05-97.1 and 97.2 HPAP. It corresponds to the completion of the 4 steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Reference, Solution and Assumptions and Step 2 – Understand the Human Performance Implications Step 3 – Improve and Validate the concept and Step4 – Collate findings & conclude on TRL4 phase. The outputs of the 4 steps are described and used to derive Human Performance requirements and demonstrate the TRL4 maturity achievement of “ HMI Interaction modes for Airport Tower”. The following activities have been conducted to mature the solution:

- Workshops
 - Workshop 1 Series
 - HP and Safety Change and Scoping assessment executed in Q2 2020
 - Workshop 2 Series
 - Final HP and Safety workshop executed in Q3 2022
- Validation Exercises:
 - EXE-05.97.1-TRL4-TVALP-VAR-001 – A real-time simulation addressing the use of new interaction modes for controllers in the aerodrome control tower of Schiphol airport
 - EXE-05.97.1-TRL4-TVALP-VAR-002 – A Real Time simulation addressing Virtual/Augmented Reality Tower Tools, Tracking Labels and Air Gesture Interaction at Bologna Airport
 - EXE-05.97.2-TRL4-TVALP-ASR-004 – A real time simulation addressing Speech Recognition at Norwegian airports in a multiple remote tower environment
 - EXE-05.97.1-TRL4-TVALP-VAR-005 – A Real Time simulation addressing Virtual and augmented reality + Tracking Label and Air Gestures at a Vitoria airport
 - EXE-05.97.2-TRL4-TVALP-ASR-006 – A Real Time simulation addressing Assistant Based Speech Recognition simulating three generic (multiple remote) airports adapted from existing airports at DLR Braunschweig Tower Lab.
 - EXE-05.97.2-TRL4-TVALP-ASR-007: Real Time simulation addressing Speech Recognition run at Rome, simulating Sofia airport.

It includes the results for the solutions PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower and PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning.

HP Issues, Benefits and relevant identified requirements and recommendations are reported to be further assessed and validated in next TRL6 phase.

According to the collected results, both the solutions are considered to have achieved the TRL4 level of maturity and are ready for the next phase.

2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the HP issues, mitigations, HP objectives, the HP activities and derived HP recommendations and requirements according to the Human Performance (HP) assessment process [1]. This document forms the TRL4 HP report for the solutions PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower and PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning.

2.2 Intended readership

This document is mainly intended for:

- **SESAR 3 JOINT UNDERTAKING (S3JU)** as SESAR 2020 Programme coordinator.
- **SESAR 2020 PJ.05-W2** consortium members in order to be aware of activities and methods developed, so that coherency, consistency and comparability of the validation results are ensured through all SESAR 2020 solutions within the project.
- **SESAR 2020 Solution PJ.10-W2-96 AG** Solution members in order to have a common and shared view on the Attention Guidance technology.
- **SESAR 2020 Solution PJ.10-W2-96 ASR** Solution members in order to have a common and shared view on the Automatic Speech Recognition technology.
- **SESAR 2020 PJ.19 Content Integration** that aims at assuring coherency, consistency, and comparability of the validation results throughout all SESAR2020 Solutions.
- Any **SESAR 2020 solution**, which wants to use aspects of any development in SOL 97
- **ER4 Project HAAWAIL** members, in order to have a common and shared view on the Automatic Speech Recognition technology.
- **Academic Researchers** in the fields of the four main concepts developed as part of PJ.05-W2-97.1 and 97.2:
 - Virtual and Augmented Reality
 - Air Gestures
 - Attention Guidance
 - Automatic Speech Recognition
- Representatives of civil stakeholders: **ANSPs**.

2.3 Structure of the document

The document includes the following sections:

- Executive Summary
- Introduction
- The Human Performance Assessment
- Appendix A – Additional HP activities conducted
- Appendix B – HP Recommendations Register
- Appendix C – HP Requirements Register
- Appendix D – HP Log

Each section include sub-sections for each of the solutions:

- PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower
- PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning.

2.4 Acronyms and Terminology

Term	Description
Human Factors (HF)	HF is used to denote aspects that influence a human's capability to accomplish tasks and meet job requirements. These can be external to the human (e.g. light & noise conditions at the work place) or internal (e.g. fatigue). In this way, "Human Factors" can be considered as <i>focussing on the variables that determine Human Performance</i> .
Human Performance (HP)	HP is used to denote the human capability to successfully accomplish tasks and meet job requirements. In this way, "Human Performance" can be considered as <i>focussing on the observable result of human activity in a work context</i> . Human Performance is a function of Human Factors (see above). It also depends on aspects related to Recruitment, Training, Competence, and Staffing (RTCS) as well as Social Factors and Change Management.
HP activity	An HP activity is an evidence-gathering activity carried out as part of Step 3 of the HP assessment process. An HP activity can relate to, among others, task analyses, cognitive walkthroughs, and experimental studies.
HP argument	An HP argument is an HP claim that needs to be proven through the HP Assessment Process.

HP assessment	An HP assessment is the documented result of applying the HP assessment process to the SESAR Solution-level. HP assessments provide the input for the HP case.
HP assessment process	The HP assessment process is the process by which HP aspects related to the proposed changes in SESAR are identified and addressed. The development of this process constitutes the scope of Project 16.04.01. It covers the conduct of HP assessments on the Solution-level as well as the HP case building over larger clusters of Solutions.
HP benefit	An HP benefit relates to those aspects of the proposed ATM concept that are likely to have a positive impact on human performance.
HP case	An HP case is the documented result of combining HP assessments from Solutions into larger clusters (SESAR Projects, deployment packages) in SESAR.
HP issue	An HP issue relates to those aspects in the ATM concept that need to be resolved before the proposed change can deliver the intended positive effects on Human Performance.
HP impact	An HP impact relates to the effect of the proposed solution on the human operator. Impacts can be positive (i.e. leading to an increase in Human Performance) or negative (leading to a decrease in Human Performance).
HP recommendations	HP recommendations propose means for mitigating HP issues related to a specific operational or technical change. HF recommendations are proposals that require additional analysis (i.e. refinement and validation). Once this additional analysis is performed, HF recommendations may be transformed into HF requirements.
HP requirements	HP requirements are statements that specify required characteristics of a solution from an HF point of view. HP requirements should be integrated into the DOD, OSED, SPR, or specifications. HF requirements can be seen as the stable result of the HF contribution to the Solution, leading to a redefinition of the operational concept or the specification of the technical solution.

Table 1: Acronyms and terminology

3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP assessment 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.

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).

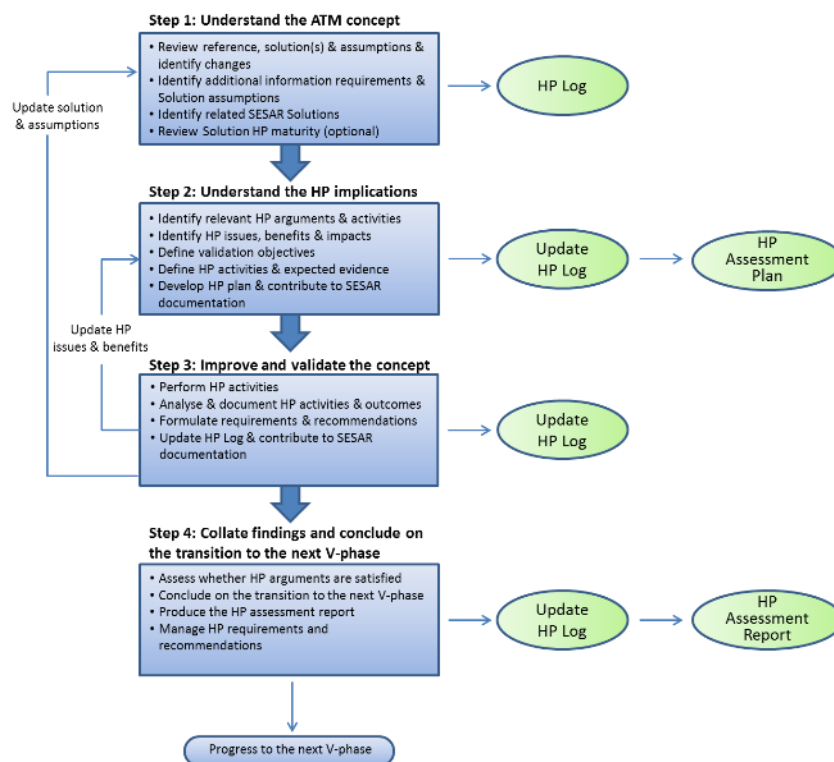


Figure 1: Steps of the HP assessment process

In addition, an HP Log 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. This HP Log is a living document and is continuously updated and / or added to as the SESAR Solution progresses.

Throughout the HP assessment process, the HP experts collaborate with the other Transversal Areas (TAs) in order to ensure that there is not overlap between the objectives defined or that there are no issues/benefits that have not been considered. Safety is one of the TAs with whom the HP experts interact the most, from identifying the list of changes and activities that will be included in the HP Plan to conducting joint workshops following the validation exercises. A detailed overview of the synergies with other TAs can be found in the HP reference Material.

Although planned in one single HPAP the Human Performance Assessment Process above described is separately conducted for the following three different solutions in PJ05-W2-WP3 scope:

- PJ.05-W2-97.1, addressing Virtual/Augmented Reality applications for tower;
- PJ.05-W2-97.2, addressing Improving controller productivity by ASR at the TWR CWP;

The following chapters will provide a detailed view on each of these solutions.

4 Human Performance Assessment PJ.05-W2-97-1

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

Solution operational environment is Tower Environment characterised high-level by the following points:

- Airport Size: Very large / Medium / Small
- Traffic
 - Aircraft Fleet mix: All types of aircraft
 - VFR, IFR: Commercial/Cargo/Freight
- Ground ATM capabilities /Systems: A-SMGCS / FDP / EFPS or Paper Strips / Voice COM
- Airport Layout
 - Single and Multiple Airport Runways
 - Complex taxiway layout, multiple intersections and runway entries
 - Multiple Aprons

EATMA defined roles involved in the reference scenarios are:

- TWR CL DEL ATCO
- TWR GND ATCO
- TWR RWY ATCO

These three roles might be delivered by one single air traffic controller or TWR CL DEL ATCO and TWR GND ATCO might be delivered by one single controller.

4.1.2 Description of solution scenario

The solution PJ05.97.1 is focused on Virtual/Augmented Reality at the tower CWP split in 3 main areas of investigation and assessment:

- V/AR in ATC Tower environment supports the Air Traffic Controllers by blending real world images with computer-generated data (virtual reality) in real-time, so that visual information

can be enhanced to improve identification and tracking of aircraft (or vehicles) on the airport surface.

- Gesture recognition is a type of perceptual computing user interface that allows computers to capture and interpret human gestures as commands via mathematical algorithms. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Users can use simple air gestures to control or interact with devices without physically touching them.
- The Attention Guidance system needs to analyze whether the information for controllers is relevant in the current situation and therefore requires their attention and, optionally, where the controllers are currently looking at. Aircraft radar data, flight plan data, and airspace data are taken into account to evaluate the current air traffic situation and give weights for different ATC events. Prioritization of events criticality (e.g. RMCA, CMAC, CATC alert) will decide how the ATCo's attention shall be raised.

The solution scenario is TWR environment with the same characteristic of the reference scenario, except that the TWR controller is supported by the Virtual/Augmented Reality at the tower CWP.

EATMA defined roles involved in the solution scenarios are the same as for the reference scenario:

- TWR CL DEL ATCO
- TWR GND ATCO
- TWR RWY ATCO

These three roles might be delivered by one single air traffic controller or TWR CL DEL ATCO and TWR GND ATCO might be delivered by one single controller.

4.1.3 Consolidated list of assumptions

The following table summarises the consolidated assumptions for PJ05.97.1

Assumptions Title and Description	Source
PJ05-97.1 V/A-R, air gesture and attention guidance	
<ul style="list-style-type: none"> • Air Gesture Technology requires deployment of V/A-R head-up interface 	W2-PJ05-97
<ul style="list-style-type: none"> • Attention Guidance Technology requires deployment of V/A-R head-up interface 	W2-PJ05-97
<ul style="list-style-type: none"> • Virtual/Augmented Reality, air gesture and attention guidance technologies can coexist at the same airport 	W2-PJ05-97

<ul style="list-style-type: none"> Virtual/Augmented Reality head-up interface view, air gesture and attention guidance are available and customised for any ATCO roles involved and the relevant responsibilities 	W2-PJ05-97
<ul style="list-style-type: none"> Virtual/Augmented Reality, air gesture and attention guidance technologies can be deployed without affecting current tower tools and technologies 	W2-PJ05-97
<ul style="list-style-type: none"> Virtual/Augmented Reality, air gesture and attention guidance technologies can be deployed and provide benefits in paper strip tower environment and in electronic strip environment 	W2-PJ05-97
Operating Methods / Traffic Characteristics	
<ul style="list-style-type: none"> Virtual/Augmented Reality, air gesture and attention guidance technologies can support ATCO in the management of any kind of traffic, including RPAS 	W2-PJ05-97
<ul style="list-style-type: none"> Virtual/Augmented Reality, air gesture and attention guidance can support different airport layout usage configurations at the controlled airport (e.g. different runway configuration, different views on the runway) are possible 	W2-PJ05-97
Weather Conditions	
<ul style="list-style-type: none"> Different visibility conditions might occur at the controlled airport using V/A-R (resulting in different operational procedures e.g. different CAT/VIS conditions, night and daytime) 	W2-PJ05-97
Human actors	
<ul style="list-style-type: none"> Human actors in the tower that may use the technology are: <ul style="list-style-type: none"> TWR CL DEL ATCO TWR GND ATCO TWR RWY ATCO 	W2-PJ05-97
<ul style="list-style-type: none"> TWR CL DEL ATCO, TWR GND ATCO, TWR RWY ATCO roles might be delivered by one single air traffic controller or TWR CL DEL ATCO and TWR GND ATCO might be delivered by one single air traffic controller 	W2-PJ05-97
Training/ Licensing:	
<ul style="list-style-type: none"> Controllers are familiar with the operating environment and tools, including Virtual/Augmented Reality, air gesture and attention guidance. 	W2-PJ05-97

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

No related SESAR solutions have been identified to be considered in the HP assessment for solution PJ05-97.1.

4.1.5 HP maturity of the Solution

PJ05.97.1 W2 aims at maturing TRL4 level of maturity POI-0039-SDM “Equivalent visual operations for tower control through the use of applications for Virtual/Augmented Reality” preliminary operational improvement that has been declared as TRL2 at the beginning of the execution phase of PJ05-97.1.

4.1.6 Identification of the nature of the change

The following table collects the changes on Human Performance Arguments areas (Roles and Responsibilities, Human and Systems, Teams & Communication, HP Related Transition Factors) introduced by PJ05.97.1 V/A-R. The changes have been identified through workshop involving solution members.

HP branch	argument	Change & affected actors V/A-R	Change & affected actors Air Gesture	Change & affected actors Attention Guidance
1. ROLES & RESPONSIBILITIES				
1.1	ROLES & RESPONSIBILITIES	No changes are expected in the roles and responsibilities	No changes are expected in the roles and responsibilities	No changes are expected in the roles and responsibilities

<p>1.2 OPERATING METHODS</p>	<p>Virtual and Augmented reality devices are expected to introduce changes in terms of operating methods and procedures as:</p> <ul style="list-style-type: none"> • ATCO can monitor tracking label in head-up instead of head-down devices; • to use V/A-R layer in low visibility conditions with the provision of wind/weather information and airport layout overlay in the head-up device. <p>This might reduce the need of head down time and might improve ATCO workload and situation awareness reducing the ATCO need of switch between head down CWP HMI and out of the window view.</p> <p>This might also improve ATCO situation awareness in LVC thanks to the provision of synthetic view of the airport layout and usage (aircraft and vehicles movements tracking) if the system works as intended.</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case of malfunction and abnormal or degraded mode.</p> <p>Also, the equipment worn on the head might be experienced as limiting the view on the CWP. For the operating methods, it is necessary to look more into the roles that ATCOs might have and what kind of information they need to perform their tasks.</p> <p>A potential new requirement is to mark the limits of the augmented reality FOV.</p> <p>The issue of operating methods has been closed for V/A-R but should stay open for non-nominal/low-visibility conditions.</p>	<p>Air gesture is expected to introduce changes in terms of operating methods and procedures as the ATCO is expected to interact with virtual reality device to change the visualization and to provide non-critical clearances through predefined air gestures instead of the manual interaction with CWP HMI devices.</p> <p>This might reduce the need of head down time and might improve ATCO workload and situation awareness reducing the ATCO need of switch between head down CWP HMI and out of the window view.</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case of malfunction and abnormal or degraded mode.</p> <p>Also, the fact that hand gestures might take more time to execute may contribute to the above-mentioned factors.</p> <p>The issue of operating methods is left open for Air Gesture.</p>	<p>Attention Guidance is expected to introduce changes in terms of operating methods and procedures as the ATCO's attention will be recalled and guided by the new technology instead of requiring a periodic head-down scan view of CWP-HMI, improving situation awareness.</p> <p>This might reduce ATCO workload reducing the need of head down time and the need of switch between head down CWP HMI and out of the window view.</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case of malfunction and abnormal or degraded mode.</p> <p>The issue of operating methods is left open for Attention Guidance.</p>
<p>1.3 TASKS</p>	<p>Virtual and Augmented reality devices are expected to complement monitoring task of CWP HMI with monitoring of out of the window view</p>	<p>Air Gesture recognition is expected to partially replace physical interactions with CWP to</p>	<p>Attention guidance is expected to reduce the visual scan of head-down CWP HMI and ATCOs</p>

HP branch	argument	Change & affected actors	Change & affected actors	Change & affected actors
		V/A-R	Air Gesture	Attention Guidance
		<p>(although in a transition phase, both systems might be needed), thanks to the provision of information superimposed by the V/A-R interface onto the real out of the window view. This is expected to reduce head-down time.</p> <p>This might improve ATCO workload and situation awareness reducing the ATCO need of switch between head down CWP HMI and out of the window view.</p> <p>This might also improve ATCO situation awareness in LVC thanks to the provision of synthetic view of the airport layout and usage (aircraft and vehicles movements tracking) if the system works as intended, with potential benefit on resilience (possibly reducing LVC restrictions) and ATCO productivity (possibly adding movements per ATCO on duty in LVC).</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload and human error in case of malfunction and abnormal or degraded mode.</p>	<p>navigate in the head-up interface displayed information and to provide GND controller clearances of push-back and start-up.</p> <p>This might reduce the need for head-down and switch between head-up and head-down as well as possibly reduce the workload. This might also improve ATCO productivity (timely task execution efficiency) thanks to the automation.</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload and human error in case of malfunction and abnormal or degraded mode.</p>	<p>reaction time by providing head-up alert and indications of ATC critical situations and (spatial) auditory cues.</p> <p>It might also support the thought process of ATCO since the guidance may not be limited to visual guidance for example comprise checklists or relevant information that is needed when looking in a particular direction as well.</p> <p>This might improve situation awareness</p> <p>On the other hand, there might be potential negative effects on situation awareness, stress level and frustration, workload and human error in case of malfunction and abnormal or degraded mode.</p>
2. HUMAN & SYSTEM				

HP branch	argument	Change & affected actors	Change & affected actors	Change & affected actors
		V/A-R	Air Gesture	Attention Guidance
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	OF	No changes are expected in terms of allocation of tasks (human & System)	No changes are expected in terms of allocation of tasks (human & System)	<p>No significant changes are expected in terms of allocation of tasks (human & System) even if Attention guidance to ATC critical situation is expected to reduce ATCO CWP-HMI scan in head- down.</p> <p>This might lead to the reduction of potential for human error (missed alerts) but might also introduce potential for overreliance on the attention guidance tool support.</p> <p>Eventually (in further future developments of the technologies) the AI behind the V/AR system might take the lead in solving complicated situations. There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case of malfunction and abnormal or degraded mode.</p> <p>Provided that the visual cues are always visible, no mitigation needed and both issues can be closed.</p>

HP branch	argument	Change & affected actors V/A-R	Change & affected actors Air Gesture	Change & affected actors Attention Guidance
2.2 PERFORMANCE OF TECHNICAL SYSTEM		<p>ATCO productivity benefits thanks to the performances of the technical system increasing head-up time and reducing switch between out of the window view and head down CWP HMI if the system works as intended.</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p> <p>Usability, acceptance, and user satisfaction might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness/misalignment of V/AR layers and tracking labels)</p> <p>An algorithm should support smooth movement of real-time data labels.</p> <p>A couple of different modes should be offered (limited tailoring) to provide the ATCO with information.</p> <p>V/A-R TL should be tested in different lighting conditions and for different types of visual impairment as different views from different angels and personal glasses can confuse or mislead ATCO.</p> <p>The V/A-R system and functions affect the strip base. This should be further investigated.</p>	<p>ATCO productivity benefits thanks to the performances of the technical system replacing head down CWP HMI interactions by air gesture interactions if the system works as intended.</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p> <p>Usability, acceptance, and user satisfaction might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness/responsiveness of air gesture)</p>	<p>Air Gesture only impacts the ground ATCO (and only certain tasks).</p> <p>ATCO productivity benefits, head-up time and situational awareness benefits thanks to the performances of the technical system guiding controller's attention to ATC critical situation if the system works as intended.</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p> <p>Usability, acceptance, and user satisfaction might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness/annoying alarm from Attention Guidance).</p> <p>The issues can be closed because they are not specific to Air Gesture.</p>

HP branch	argument	Change & affected actors V/A-R	Change & affected actors Air Gesture	Change & affected actors Attention Guidance
2.3 MACHINE INTERFACE	HUMAN –	<p>Output devices (CWP-HMI) are expected to be complemented: A/V-R head-up interface will provide information currently only available in the head down devices CWP-HMI e.g. tracking labels, wind conditions. A/V-R is expected to also provide airport overlays to support LVC operations and provide controllers with synthetic view support to conduct air traffic control with equivalent-to-good visibility conditions (e.g. airport layout, vehicles and aircraft movements).</p> <p>This is expected to improve controller situational awareness in LVC and ATCO productivity if the system works as intended.</p> <p>Usability, acceptance, workload, situation awareness and user satisfaction might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness of V/AR layers and tracking labels).</p> <p>V/A-R labels should be designed in a way that they do not cover the OTW.</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p>	<p>Input devices (mouse, keyboard/digital pen) are expected to be complemented: air gesture to interact with A/V-R head-up interface will support controllers in the navigation of visualization interface and in the provision of GND clearances of start-up and push-back.</p> <p>This is expected to improve usability, acceptance, workload, situation awareness and user satisfaction but these HP indicators might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness responsiveness of air gesture).</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p> <p>V/A-R air gestures are not intuitive. This could be mitigated by training. It is difficult to measure and define a recognition rate for Air Gestures.</p>	<p>Output devices (CWP-HMI) are expected to be complemented: A/V-R Attention Guidance head-up interface will provide alerts and safety warnings currently only available in the head down devices CWP-HMI. Attention guidance will also track and monitor controller's attention to guide the gaze to the ATC safety critical situation when controller is looking elsewhere.</p> <p>This is expected to improve controller situational awareness and effectiveness.</p> <p>There might be potential negative effects on situation awareness, stress level and frustration, workload, and human error in case the performances of the technical system are not as expected or in case of malfunction and abnormal or degraded mode.</p> <p>Usability, acceptance, and user satisfaction might also be negatively affected in case the performances of the technical system are not as expected (accuracy/effectiveness/ /annoying alarm from Attention Guidance)</p>
3. TEAMS & COMMUNICATION				

HP branch	argument	Change & affected actors V/A-R	Change & affected actors Air Gesture	Change & affected actors Attention Guidance
3.1 COMPOSITION	TEAM	No changes are expected in terms of team composition. There could be an issue in case of a large airport.	No changes are expected in terms of team composition	No changes are expected in terms of team composition
3.2 TASKS	ALLOCATION OF TASKS	No changes are expected in tasks allocation between human actors. Allocation of tasks might change depending on the local situation. Team SA could be positively impacted by the solution.	No changes are expected in tasks allocation between human actors	No changes are expected in tasks allocation between human actors
3.3 COMMUNICATION		No changes are expected in communication among human actors (TWR and Cockpit) in terms of both means and phraseology, but there might be potential for communication misunderstandings as ATCOs might get information on their displays that other persons will not see, as not equipped with V/A-R displays, or equipped with different views (e.g. TWR RWY ATCO and TWR GND ATCO both equipped with same display providing them with a customised view on the role).	No changes are expected in communication among human actors (TWR and Cockpit) in terms of both means and phraseology.	No changes are expected in communication among human actors (TWR and Cockpit) in terms of both means and phraseology.
4. HP RELATED TRANSITION FACTORS				
4.1 JOB SATISFACTION	ACCEPTANCE &	A/V-R support might improve job acceptance and satisfaction in case of very good system performance and in general smooth new technology might attract new ATCOs, but might also negatively affect both job acceptance and satisfaction in case of abnormal and degraded mode (malfunction) or low system performance (e.g. accuracy/effectiveness/misalignment of V/AR layers and tracking labels)	A/V-R Air Gesture support might improve job acceptance and satisfaction in case of very good system performance and in general smooth new technology might attract new ATCOs, but might also negatively affect both job acceptance and satisfaction in case of abnormal and degraded mode (malfunction) or low system performance (e.g. accuracy/effectiveness/responsiveness of air gesture, timeliness)	A/V-R Attention Guidance support might improve job acceptance and satisfaction in case of very good system performance and in general smooth new technology might attract new ATCOs, but might also negatively affect both job acceptance and satisfaction in case of abnormal and degraded mode (malfunction) or low system performance (e.g. accuracy/effectiveness/annoying alarm from Attention Guidance)

HP branch	argument	Change & affected actors	Change & affected actors	Change & affected actors
		V/A-R	Air Gesture	Attention Guidance
4.2	COMPETENCE REQUIREMENTS	No changes are expected in terms of competence requirements	No changes are expected in terms of competence requirements	No changes are expected in terms of competence requirements
4.3	STAFFING REQUIREMENTS & STAFFING LEVELS	No changes are expected in terms of staffing levels and requirements	No changes are expected in terms of staffing levels and requirements	No changes are expected in terms of staffing levels and requirements
4.4.	RECRUITMENT AND SELECTION	No changes are expected in terms of recruitment and selection	No changes are expected in terms of recruitment and selection	No changes are expected in terms of recruitment and selection
4.5.	TRAINING NEEDS	The controllers will need to be trained on the A/V-R functionalities and system knowledge with consequent changes in the content of training	The controllers will need to be trained on the A/V-R Air Gesture functionalities and system knowledge with consequent changes in the content of training	The controllers will need to be trained on the A/V-R Attention Guidance functionalities and system knowledge with consequent changes in the content of training

Table 2: Description of the change

4.2 Step 2 Understand the HP implications

4.2.1 Relevant arguments, issues & benefits and HP activities

The next table provides the identified Relevant arguments, issues & benefits and HP activities for the solution PJ.05-W2-97.1.

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.	W2.PJ05.97-HP-V/A-R-59	Operating methods with the introduction of V/A-R tracking labels, V/A-R air gestures and V/A-R attention guidance are not clearly identified for normal, abnormal and degraded mode conditions, negatively affecting trust in the new technology	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1030	To assess that the role of the ATCO is consistent with human capabilities and limitations with the introduction of V/A-R Tracking labels and overlays	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1031	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using V/A-R	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97-1-TLR4-TVALP-H103-1032	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly identified and consistent in all operating conditions when using V/A-R	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97.1-TLR4-TVALP-H104-1021	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using V/A-R Air Gesture	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97.1-TLR4-TVALP-H104-1022	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly identified and consistent in all operating conditions when using V/A-R Air Gesture	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.	W2. PJ05.97- HP-V/A- R_TRL4_1	Head-up display of conflict improving user experience not having to search for information about where the conflict is, and which a/c (call signs) are involved	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop	To be addressed in next TRL phase							
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).	W2.PJ05.97-HP-V/A-R-9	Failure of V/A-R Tracking label requires ATCO to recover to current operating methods with a consequent decrease in situation awareness and a lack in the operating methods if failure recovery operational procedures are not described.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1030	To assess that the role of the ATCO is consistent with human capabilities and limitations with the introduction of V/A-R	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1031	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate,	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		This might negatively affect ATCO productivity The issue also affects arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]				Tracking labels and overlays				efficient and timely manner when using V/A-R		
									CRT-05.97.1-TLR4-TVALP-H103-1032	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly identified and consistent in all operating conditions	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activity/ies	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ns when using V/A-R		
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-V/A-R-29	V/A-R attention guidance visual cues are only visible from specific angles and ATCO needs to frequently turn the head to recognise the alert, causing an increase of workload and affecting usability. This issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]				their tasks				using V/A-R Attention Guidance Technology		
									CRT-05.97.1-TRL4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										of situation awareness		
									CRT-05.97.1-TLR4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidance	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ce Technology		
									CRT-05.97-1-TLR4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-V/A-R-30	V/A-R attention guidance visual cues guiding the ATCO's gaze on a safety critical event are only visible from specific angles and ATCO needs to frequently turn the head to recognise the direction where the attention is required, causing an increase of workload and affecting usability. This might also	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing their tasks	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Attention Guidance	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		affect safety. This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]								Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level of	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										situation awareness		
									CRT-05.97.1-TLR4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidan	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ce Technology		
									CRT-05.97-1-TLR4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-12	V/A-R Tracking label does not provide adequate information (e.g. latest updated information; needed information) and ATCO is not supported by the HMI for the needed information, negatively affecting situation awareness, human error, ability to accomplish tasks and focus on primary tasks. This issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]							CRT-05.97.1-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										e level of situation awareness		
									CRT-05.97.1-TRL4-TVALP-H103-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-8	Tracking label of V/A-R is detached (e.g. is frozen or not aligned) from the relevant object (aircraft/vehicles) causing confusion and annoyance to ATCO with a possible decrease in situation awareness, job acceptance and satisfaction and a possible increase in workload and potential for human error. This might negatively affect ATCO	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		productivity. The issue also affects arguments: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a							CRT-05.97.1-TRL4-TVALP-H103-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Technology	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1015	HMI of V/A-R tools does not overshadow the relevant	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		sufficient level of situation awareness. Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.								information on the OTW view		TRL4-TVALP-VAR-005
									CRT-05.97.1-TLR4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										awareness		
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-15	V/A-R Tracking label different views from different angles confuse or mislead ATCO with potential increase in human error and decrease of situation awareness and negatively affecting the ability to accomplish tasks. This issue also affects argument: Arg. 2.3.8: The	closed	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.971-TRL4-TVALP-	V/A-R HMI does not increase the potential	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		user interface supports a sufficient level of individual situation awareness. [V1: AIR only]							H103-1016	I for human error		05.97.1-TRL4-TVALP-VAR-005
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-20	V/A-R system and functions affecting existing CWP systems and tools causing ATCO decrease in situation awareness and ability to accomplish tasks. This issue also affects arguments: Arg. 1.3.2: Tasks can be achieved in a timely manner. Arg. 1.3.5:	Closed	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		Human actors can maintain a sufficient level of situation awareness								awareness		
									CRT-05.97.1-TLR4-TVALP-H103-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_2	•V/A-R system causes heavy head due to the weight of the head device	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop		To be addressed in next TRL phase						
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_3	•V/A-R system head device causes reflections of surrounding light, and the reflection is also worst in combination with personal glasses	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop		To be addressed in next TRL phase						

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-21	BENEFIT: V/A-R air gesture interaction reduces workload replacing a CWP head down interaction with a smart and head-up interaction means. This might also affect ATCO productivity	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H104.1010	To assess that the technical systems for V/A-R Air Gestures support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H104-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Air Gestures Technology	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
							ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.97.1-TRL4-TVALP-H104-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario	Observations / Customised questionnaire / Log Analysis	EXE-05.97.1-TRL4-TVALP-VAR-002
							ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.97.1-TRL4-TVALP-H104-1017	Majority of ATCOs' responses (at least 75%) is that the level of usability is	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										adequate when using V/A-R Air Gestures HMI		VAR-005
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_4	•V/A-R air gestures not intuitive	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop	To be addressed in next TRL phase							
Arg. 2.3.2: Input devices (e.g. keyboard, mouse,	W2.PJ05.97-HP-V/A-R_TRL4_5	•Benefit: ATCO reaction times decrease with V/A-R TL	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF	To be addressed in next TRL phase							

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
touch screen) correspond to HF principles . [V1: AIR only]				Workshop								
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_6	•V/A-R system causes heavy head due to the weight of the head device and not usable during an entire shift	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop			To be addressed in next TRL phase					
Arg. 2.3.2: Input devices (e.g. keyboard, mouse,	W2.PJ05.97-HP-V/A-R_TRL4_7	•V/A-R system head device causes reflections of surrounding light, and the reflection is also	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF			To be addressed in next TRL phase					

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
touch screen) correspond to HF principles . [V1: AIR only]		worst in combination with personal glasses		Workshop								
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_8	•Attention guidance providing algorithm not advanced causing nuisance alerts (e.g. alerts for taxi conflict displayed to TWR ATCO not responsible of it, alert notice disappearing when facing the direction of the conflict, but reappearing after a certain interval when the separation	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop		To be addressed in next TRL phase						

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		remained below the set minima, even if the conflict solved)										
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_9	•Benefit: ATCO reaction times decrease with the A-R guidance	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop			To be addressed in next TRL phase					
Arg. 2.3.2: Input devices (e.g. keyboard, mouse,	W2.PJ05.97-HP-V/A-R_TRL4_10	•V/A-R system limited field of view head movements being tiring	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF			To be addressed in next TRL phase					

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
touch screen) correspond to HF principles . [V1: AIR only]				Workshop								
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_11	•V/A-R system images appearing too brightly on top of the background	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop			To be addressed in next TRL phase					
Arg. 2.3.2: Input devices (e.g. keyboard, mouse,	W2.PJ05.97-HP-V/A-R_TRL4_12	•V/A-R system display coated and not acceptable in many cases, as at night, during bad weather	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF			To be addressed in next TRL phase					

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
touch screen) correspond to HF principles . [V1: AIR only]		conditions or when studying information (on paper) on the controller working position		Workshop								
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_13	•V/A-R system causes heavy head due to the weight of the head device and not usable during an entire shift	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop						To be addressed in next TRL phase		
Arg. 2.3.3: Visual displays and other types of output devices	W2.PJ05.97-HP-V/A-R_TRL4_14	V/A-R system limited field of view head movements being tiring	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop						To be addressed in next TRL phase		

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
adhere to HF principles . [V1: AIR only]												
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_15	V/A-R system limited field of view not known by ATCO	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop			To be addressed in next TRL phase					
Arg. 2.3.3: Visual displays and other types of output devices	W2.PJ05.97-HP-V/A-R_TRL4_16	V/A-R system limited field of view too limited	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop			To be addressed in next TRL phase					

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
adhere to HF principles . [V1: AIR only]												
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_17	•V/A-R data based on live data not reliable (e.g. data dropouts during final approach)	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop								
	W2.PJ05.97-HP-V/A-R_TRL4_18											
Arg. 2.3.3: Visual displays and other types of output	W2.PJ05.97-HP-V/A-R_TRL4_19	V/A-R system display coated and not acceptable in many cases, as at night, during bad weather	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF								

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
devices adhere to HF principles . [V1: AIR only]		conditions or when studying information (on paper) on the controller working position		Workshop								
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R_TRL4_20	V/A-R system images appearing too brightly on top of the background	Open	PJ05.97 TRL4 TVALR/ FINAL HP & SAF Workshop								
Arg. 2.3.3: Visual displays and other types of output devices	W2.PJ05.97-HP-V/A-R-6	Benefit :V/A-R Tracking labels increase situation awareness providing flight information in primary tower	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
adhere to HF principles . [V1: AIR only]		point of view (out of the window)				Tracking labels and overlays support the ATCOs in performing their tasks				level and quality of information is adequate, complete and acceptable when using V/A-R Technology	SASHA / SART	TRL4-TVALP-VAR-005
									CRT-05.97.1-TLR4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI support		EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										s ATCO in maintaining an adequate level of situation awareness		VAR-005
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles . [V1: AIR only]	W2.PJ05.97-HP-V/A-R-7	Benefit :V/A-R Tracking labels display reduces the need of head-down time.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario	Observations / Customised questionnaire / Log Analysis	EXE-05.97.1-TRL4-TVALP-VAR-002

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
						ng their tasks			CRT-05.97.1-TLR4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-27	V/A-R attention guidance alerts are too intrusive and disturb ATCO, generating annoyance with consequent increase in stress level and decrease of job satisfaction and acceptance. This issue also affects arguments: Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing their tasks	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-001
									CRT-05.971-TRL4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										n Guidance HMI supports ATCO in maintaining an adequate level of situation awareness		
									CRT-05.97-1-TRL4-TVALP-H105-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R Attention Guidance	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										acceptance is adequate		
									CRT-05.97.1-TLR4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidan	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ce Technology		
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-35	V/A-R attention guidance additional perception cues raised in the augmented reality device in case of potentially missed command actions disturbed the ATCO who intentionally postponed command actions with	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105-1010		NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		consequent increase of workload								using V/A-R Attention Guidance Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										of situation awareness		
									CRT-05.97.1-TLR4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidan	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ce Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97-1-TLR4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Attention Guidance	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										Technology		
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-19	V/A-R tracking labels to present conflict detection alerts are too intrusive and disturb the ATCO, generating annoyance with consequent increase in stress level and decrease of job satisfaction and acceptance. This issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performi	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R Attention Guidance acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		arguments: Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.				ing their tasks			CRT-05.97.1-TRL4-TVALP-H104-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Air Gestures Technology	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-22	V/A-R air gesture interaction is not timely responding, and the lack of responsiveness causes ATCO frustration, increase in workload and decrease of ability to accomplish tasks and focus on primary tasks. This issue also affects arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H104.1010	To assess that the technical systems for V/A-R Air Gestures support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H104-1017	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R Air Gestures HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.971-TRL4-TVALP-H104-1011	Majority of ATCOs' responses (at least 75%) is that workload is	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		user interface design reduces human error as far as possible. [V1: AIR only]								maintained at acceptable level when using V/A-R Air Gestures Technology		VAR-005
									CRT-05.97.1-TRL4-TVALP-H104-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference	Observations / Customised questionnaire / Log Analysis	EXE-05.97.1-TRL4-TVALP-VAR-002

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										scenario		
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-23	V/A-R air gesture interaction is recognising wrong gesture and providing a wrong input to the system realised by ATCO causing ATCO decrease in the trust of the system and negatively affecting workload. This issue also affects arguments: Arg. 2.2.2: The timeliness of	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H104.1010	To assess that the technical systems for V/A-R Air Gestures support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H104-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Air Gestures	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]								Technology		
									CRT-05.97.1-TRL4-TVALP-H104-1017	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R Air Gestures HMI	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97.1-TRL4-TVALP-H104-1018	Majority of ATCOs' responses (at least 75%) is that V/A-R Air Gestures acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H104-1016	Majority of ATCOs' responses (at least 75%) is that the trust in the system is at an	SATI	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										acceptable level		
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-24	V/A-R air gesture interaction is recognising wrong gesture and providing a wrong input to the system not realised by ATCO causing increase in potential for human error, negatively affecting situation awareness This issue also affects arguments:	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H104.1010	To assess that the technical systems for V/A-R Air Gestures support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H104-1015	V/A-R Air Gestures HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.971-TRL4-TVALP-	Majority of ATCOs' responses (at least 75%) is		EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]							H104-1017	that the level of usability is adequate when using V/A-R Air Gesture s HMI		05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H104-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Air Gesture s HMI support s ATCO in maintaining an	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										adequate level of situation awareness		
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-10	V/A-R Tracking label is attached to wrong aircraft, generating confusion for the ATCO that issue clearance to wrong aircraft with consequent increase in human error, decrease in situation awareness and ability to accomplish tasks. This might negatively affect safety. The issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.971-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		arguments: Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]								HMI supports ATCO in maintaining an adequate level of situation awareness		TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										V/A-R HMI		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-25	BENEFIT: V/A-R attention guidance increases ATCO situation awareness providing head-up alerts that guide the attention to a safety critical event. This benefit might also affect safety.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
						ing their tasks			CRT-05.97.1-TRL4-TVALP-H105-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario	Observations / Customised questionnaire / Log Analysis	EXE-05.97.1-TRL4-TVALP-VAR-001
									CRT-05.97.1-TRL4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										Guidance HMI supports ATCO in maintaining an adequate level of situation awareness		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-26	V/A-R attention guidance lack of responsiveness reduces ATCO situation awareness alerting late about safety critical events, with possible increase of human error. This might affect safety. This	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		issue also affects arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.				ATCOs in performing their tasks				Attention Guidance HMI		
									CRT-05.97.1-TLR4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level of	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										situation awareness		
									CRT-05.97.1-TLR4-TVALP-H105-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the early detection of	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ATC critical situations		
									CRT-05.97.1-TLR4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										using V/A-R Attention Guidance Technology		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-11	V/A-R Tracking label overshadows the OTW view and ATCO that cannot see other vehicles or aircraft in the movement area due to the TL covering the ATCO's line of sight, negatively affecting situation awareness, human error and ability to accomplish tasks. This may	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.971-TRL4-TVALP-H103-1015	HMI of V/A-R tools does not overshadow the relevant	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		negatively affect safety. The issue also affects arguments: Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]								information on the OTW view		TRL4-TVALP-VAR-005
									CRT-05.97.1-TLR4-TVALP-H103-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R HMI	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-1	V/A-R Tracking label provides too many information and ATCO is disturbed and annoyed, negatively affecting situation awareness. This might negatively affect ATCO Productivity. This issue also affects arguments: Arg. 1.3.5: Human actors can maintain a sufficient level of	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		situation awareness.							CRT-05.97-1-TLR4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-2	V/A-R airport layers not aligned to airport layout decreases situation awareness in low visibility conditions. This issue might also affect safety. This issue also affects argument: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a sufficient level of	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		situation awareness.							CRT-05.97.1-TRL4-TVALP-H103-1015	HMI of V/A-R tools does not overshadow the relevant information on the OTW view	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness		TRL4- TVALP- VAR- 005
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05 .97-HP- V/A-R-3	Benefit: V/A-R additional information increase situation awareness in low visibility conditions and in good visibility conditions providing relevant data in the head-up tool. This benefit also	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ- 05.971- TRL4- TVALP- H103.1 010	To assess that the technical systems for V/A- R Tracking labels and overlays support the	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT- 05.97 1- TRL4- TVALP- H103- 1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is	Observations / Customised questionnaire	EXE- 05.97.1- TRL4- TVALP- VAR- 002 EXE- 05.97.1- TRL4- TVALP- VAR- 005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		affects Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness. Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.				ATCOs in performing their tasks				adequate, complete and acceptable when using V/A-R Technology		
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										of situation awareness		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-4	V/A-R additional information not adequate negatively affects situation awareness by providing not updated data and/or not relevant data and/or too many data in the head-up tool. This issue also affects: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TLR4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		principles. [V1: AIR only]								using V/A-R Technology		
									CRT-05.97.1-TLR4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										awareness		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-5	Benefit: V/A-R airport layers increase situation awareness in low visibility conditions providing overlay to out of the window view. This benefit also affects argument: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.								using V/A-R Technology		
									CRT-05.97.1-TLR4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-002 EXE-05.97.1-TLR4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										awareness		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-13	V/A-R Tracking label does not provide adequate and timely safety net advisory and ATCO is confused/misled/annoyed by alerts, negatively affecting situation awareness, human error, ability to accomplish tasks and focus on primary tasks. This might negatively affect safety.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TLR4-TVALP-H103-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the early detection of	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]				performing their tasks				ATC critical situations		
									CRT-05.97.1-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										HMI supports ATCO in maintaining an adequate level of situation awareness		TVALP-VAR-005
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-16	V/A-R tracking label distinguish code indicates lining-up aircraft for arrival flight generating ATCO's decrease of situation awareness and potential increase of human error.	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		This issue also affects argument: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]				the ATCOs in performing their tasks			CRT-05.97.1-TRL4-TVALP-H103-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-17	V/A-R tracking label fails to present conflict detection alerts generating ATCO decrease of situation awareness and possible increase of human error. This might affect safety. This issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.97.1-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]				in performing their tasks				e, complete and acceptable when using V/A-R Technology		
									CRT-05.971-TLR4-TVALP-H103-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										early detection of ATC critical situations		
									CRT-05.97.1-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										HMI supports ATCO in maintaining an adequate level of situation awareness		TVALP-VAR-005
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-18	V/A-R tracking label (to present conflict detection alerts) lack of responsiveness reduces ATCO situation awareness alerting late about safety critical events, with possible increase of human error. This might affect	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		safety. This issue also affects arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.				in performing their tasks				e, complete and acceptable when using V/A-R Technology		
									CRT-05.97.1-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										situation awareness		
									CRT-05.97.1-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005
Arg. 2.3.8: The user interface supports a sufficient level of individual	W2.PJ05.97-HP-V/A-R-28	V/A-R attention guidance fails to identify a safety critical event leading to a decrease of the ATCO's situation awareness and a possible	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention	NLR	Real Time Simulation Workshop Focus Group	CRT-05.97.1-TRL4-TVALP-H105-1016	V/A-R Attention Guidance HMI does not increase the	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activity/ies	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
situation awareness. [V1: AIR only]		increase of human error. This might affect safety. This issue also affects arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]				n Guidance support the ATCOs in performing their tasks				potential for human error		
									CRT-05.97.1-TLR4-TVALP-H105-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the early detection of	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ATC critical situations		
									CRT-05.97.1-TLR4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										Attention Guidance HMI		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-31	V/A-R attention guidance visual cues guiding the ATCO's gaze on a safety critical event fail to track ATCO's attention and provide wrong information about where the attention is needed causing a decrease of situation	closed	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP - H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		awareness. This might also affect safety. This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]				their tasks				using V/A-R Attention Guidance Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										of situation awareness		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-32	V/A-R attention guidance visual cues not recognized by ATCO due to head-mounted display overcrowded with information with a consequent decrease of ATCO situation awareness and an increase in human error. This might also	closed	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		affect safety. This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]				their tasks				using V/A-R Attention Guidance Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level	SASHA / SART	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										of situation awareness		
									CRT-05.97.1-TLR4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidan	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										ce Technology		
									CRT-05.97.1-TLR4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when	Observations / Customised questionnaire	EXE-05.97.1-TLR4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										using V/A-R Attention Guidance Technology		
									CRT-05.97.1-TRL4-TVALP-H105-1016	V/A-R Attention Guidance HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-001
									CRT-05.97.1-TRL4-TVALP-	Majority of ATCOs' responses (at least 75%) is	SUMI/SUS/Tailor-Made Questionnaires/D ebriefing	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
									H105-1018	that the level of usability is adequate when using Attention Guidance HMI		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-33	V/A-R attention guidance information overcrowding ATCO line of sight, negatively affecting ATCO situation awareness	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs	NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintain	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
						in performing their tasks				ning an adequate level of situation awareness		
									CRT-05.97.1-TRL4-TVALP-H105-1015	HMI of V/A-R Attention Guidance tools does not overshadow the relevant information on the OTW view	Observations / Customised questionnaire	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-34	V/A-R Attention Guidance different views between team members does not provide the same level of information and ATC team communication (TWR RWY/TWR GND) is negatively affected, negatively affecting team situational awareness, human error. This issue also affects	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H105-1010		NLR	Real Time Simulation Workshop Focus Group	CRT-05.971-TRL4-TVALP-H105-1021	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO team (GND and TWR) in maintaining an acceptable level of situational awareness	SASHA / SART	EXE-05.97.1-TRL4-TVALP-VAR-001

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
		arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 3.3.5: Team members can maintain a sufficient level of shared situation awareness.							CRT-05.97.1-TRL4-TVALP-H105-1016	V/A-R Attention Guidance HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-001
Arg. 2.3.9: The user Interface design supports a sufficient level of team situationa	W2.PJ05.97-HP-V/A-R-14	V/A-R Tracking label different views between team members does not provide the same level of information and ATC team communication (TWR RWY/TWR	closed	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and	ENAV / ENAIRE	Real Time Simulation Workshop Focus Group	CRT-05.97.1-TRL4-TVALP-H103-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R acceptance is	CARS / Debriefing / Observations	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
I awareness. [V1: AIR only]		GND) are negatively affected, negatively affecting team situation awareness, human error. This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 3.3.5: Team members can maintain a sufficient level of shared situation awareness.				overlays support the ATCOs in performing their tasks				adequate	SASHA / SART	VAR-005
									CRT-05.97.1-TLR4-TVALP-H103-1021	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO team (GND and TWR) in maintaining an acceptable		EXE-05.97.1-TLR4-TVALP-VAR-002

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation objectives ID	Objectives	Addressed by (project member(s))	HP activities	Success criteria ID	Expected evidence (Success criteria)	Method	Scenarios/ events in case of SESAR exercise
										level of situation awareness		
									CRT-05.97.1-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005

Table 3 V/A-R Relevant arguments, issues & benefits and HP activities

5 Human Performance Assessment PJ.05-W2-97.2

5.1 Step 1 Understand the ATM concept

5.1.1 Description of reference scenario

Solution operational environment is Tower Environment characterised high-level by the following points:

- Airport Size: All
- Traffic
 - Aircraft Fleet mix: All types of aircraft
 - VFR, IFR & GA: Commercial/Cargo/Freight
- Ground ATM capabilities /Systems: A-SMGCS / FDP / EFPS / Voice COM
- Airport Layout
 - Single and Multiple Airport Runways
 - Complex taxiway layout, multiple intersections and runway entries
 - Multiple Aprons

EATMA defined roles involved in the reference scenarios are:

- TWR CL DEL ATCO
- TWR GND ATCO
- TWR RWY ATCO

These roles can be delivered by one single air traffic controller.

5.1.2 Description of solution scenario

The solution PJ05.97.2 is focused on the Automatic Speech Recognition at Tower CWP.

The solution scenario is TWR environment with the same characteristic of the reference scenario, except that the TWR controller is supported by the Automatic Speech Recognition System.

An Automatic Speech Recognition (ASR) system gets an audio signal from the controller working position (CWP) as input and transforms it into a sequence of words, i.e. “speech-to-text” following the

recognition process. The sequence of words is transcribed into a sequence of air traffic control (ATC) concepts (“text-to-concepts”). For example, the word sequence “bonjour Air France two four eight six line up and wait runway two seven left” is transformed into “AFR2486 LINEUP RW27L”.

The ASR system may benefit from surveillance data, flight plans, meteorological data, routing information etc. - a so called Assistant Based Speech Recognition (ABSR) system. The ABSR derives command hypotheses from the contextual knowledge to support the speech recognition engine in choosing the right recognition hypotheses. This increases the command recognition rate and minimizes the command recognition error rate. The functionality chain is described in the next section¹.

The AI/ML applied to ASR function, supports the “Command Hypotheses Predictor” that periodically receives contextual information updates such as surveillance data, flight plan data, route information, clearance information, weather information etc. This information is used to predict possible future controller commands based on a machine learned command prediction model on historic surveillance and speech data.

EATMA defined roles involved in the solution scenarios are the same as for the reference scenario:

- TWR CL DEL ATCO
- TWR GND ATCO
- TWR RWY ATCO

These roles are delivered by one single air traffic controller.

The solution PJ05.97.2 can be applied in tower environment, in remote tower or multiple remote tower environment and it is not anticipated any specific development needs different for the different environments (remote/not remote) apart from local HMI needs and customization that requires further deployment assessment in TRL7 phase.

5.1.3 Consolidated list of assumptions

The following table summarises the consolidated assumptions for PJ05.97-2

Assumptions Title and Description	Source
PJ05-97.2 Automatic Speech Recognition	
<ul style="list-style-type: none">• Automatic Speech Recognition technology can support any kind of ATC Tower Clearance	W2-PJ05-97.2

¹ ABSR systems shall provide accurate output to be provided to ATCO HMIs if needed. The ABSR algorithms can simply be rule-based, but it is strongly recommended to use AI and ML techniques to learn from existing data.

<ul style="list-style-type: none"> Automatic Speech Recognition technology can be deployed in tower environment, in remote tower or multiple remote tower environment without any specific development needs different for the different environments (remote/not remote) apart from local HMI needs and customization 	W2-PJ05-97.2
<ul style="list-style-type: none"> Automatic Speech Recognition technology can be deployed without affecting current tower tools and technologies 	W2-PJ05-97.2
<ul style="list-style-type: none"> Automatic Speech Recognition technology is available and customised for any ATCO roles involved and the relevant responsibilities 	W2-PJ05-97.2
Operating Methods / Traffic Characteristics	
<ul style="list-style-type: none"> Automatic Speech Recognition technology can support ATCO in the management of any kind of traffic, including RPAS 	W2-PJ05-97.2
<ul style="list-style-type: none"> Automatic Speech Recognition technology can support different airport layout usage configurations at the controlled airport (e.g. different runway configuration are possible) 	W2-PJ05-97.2
Human actors	
<ul style="list-style-type: none"> Human actors that may use ASR are: <ul style="list-style-type: none"> TWR CL DEL ATCO TWR GND ATCO TWR RWY ATCO 	W2-PJ05-97.2
<ul style="list-style-type: none"> TWR CL DEL ATCO, TWR GND ATCO, TWR RWY ATCO roles might be delivered by one single air traffic controller or TWR CL DEL ATCO and TWR GND ATCO might be delivered by one single air traffic controller 	W2-PJ05-97.2
Training/ Licensing:	
<ul style="list-style-type: none"> Controllers are familiar with the operating environment and tools related to ASR. 	W2-PJ05-97.2

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

Related projects are:

- S1.P06.09.03 Single Remote Tower
- W2.PJ05.35 Multiple Remote Tower and Remote Tower Centre

- PJ.10-W2-96 Attention Guidance and Automatic Speech Recognition

Anyway, as already introduced in the solution scenario description, the solution PJ05.97.2 can be applied in tower environment, remote tower or multiple remote tower environment and it is not anticipated any specific development needs different for the two different environments (remote/not remote) apart from local HMI needs and customization that requires further deployment assessment in TRL7 phase. This is why the Remote Tower projects are out of the scope of the solution and will not be taken into account in the Human Performance assessment.

5.1.5 HP maturity of the Solution

PJ05.97.2 W2 aims at maturing TRL4 level of maturity POI-0040-SDM “Improving controller productivity by ASR at the TWR CWP” preliminary operational improvement that has been declared as TRL2 at the beginning of the execution phase of PJ05-97.2.

5.1.6 Identification of the nature of the change

The following table collects the changes on Human Performance Arguments areas (Roles and Responsibilities, Human and Systems, Teams & Communication, HP Related Transition Factors) introduced by PJ05.97.2 ASR. The changes have been identified through workshop involving solution members.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES	
1.1 ROLES & RESPONSIBILITIES	<p>EATMA defined roles involved in the solution scenarios are:</p> <ul style="list-style-type: none"> • Tower Clearance Delivery Controller • Tower Ground Controller • Tower Runway Controller <p>These roles are combined in one single role. No change in roles and responsibilities is expected.</p>
1.2 OPERATING METHODS	<p>The operating methods as such do not significantly change with the introduction of ASR support that will automatically highlight callsign and recognize controllers’ clearances, but there might be operational procedures requesting the ATCO to monitor and control the recognised clearance instead of a manual interaction procedure.</p> <p>Furthermore, operational procedures to recover in case of corruption/malfunction (e.g., loss of responsiveness) or loss of ASR support need to be defined and investigated</p>

HP argument branch	Change & affected actors
1.3 TASKS	<p>Controllers' tasks as such do not significantly change with the introduction of ASR support that will automatically highlight callsign and recognize controllers' clearances, but manual tasks of inputting clearances in the system will be partially replaced (up to $\pm 90\%$) by controlling and monitoring tasks and correction actions in case of need.</p> <p>This change is expected to provide benefits in terms of workload: the clearance recognition support might reduce workload, while demand, fatigue and situational awareness need to be assessed. Demand and fatigue might be reduced due to ATCO manual interaction reduction but might also increase due to ATCO being less involved and performing more monitoring than acting.</p> <p>ASR system and functions affecting existing CWP systems and tools (e.g. EFPS etc.) could cause ATCO decrease in situational awareness</p>
2. HUMAN & SYSTEM	

2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)

ASR support will automatically highlight flights that have been contacted and automatically recognize clearances issued by the ATCO via R/T communications to the flight under control, as well as highlighting flights via voice command. The manual input of the clearance by mouse/digital pen/keyboard will be replaced by the automation support of the ASR technology and thus the physical action will be replaced by controlling and monitoring tasks and correction actions in case of need.

The automatic highlight and clearance recognition might reduce the potential for human error for the clearance input and the flight selection and enhance situational awareness. This needs anyway to be assessed as it might increase or decrease, respectively, if the system is not providing adequate performance in terms of recognition rate.

Level of trust might also be improved if the system has a high recognition rate (i.e., callsign recognition rate / callsign recognition error rate / callsign recognition rejection rate / command recognition rate / command recognition error rate / command recognition rejection rate).

On the other hand, if the ASR command predictor forecasts a possible future ATCO's command that is not relevant for the ATCO communication to pilot and proposes an ATC concept based on the utterance, which is not relevant for the communicated clearance, it can annoy the ATCO that realizes the suggestion is not valid, with a potential decrease of trust in the system. Due to the late (delayed) ASR recognition and highlight of aircraft callsign the ATCO is unable to complete his/her task efficiently (recognition rate, time to wait for the recognition output):

Consequent ATCO decrease in ASR tool trust/acceptance.
Consequent decrease of ATCO trust (frustration) /acceptance of ASR tool

Abnormal and degraded modes (malfunctions) might negatively affect controller situational awareness, workload and potential for human error. In case of the system recognizing a wrong callsign it's better to not show anything rather the wrong recognized callsign. If an ATCO utters a wrong callsign, it would be helpful if the system corrects it and, in case a wrong clearance is issued, other safety nets shall intervene to prevent safety issues. In case the ASR has fully recognized the input, the colour coding should be different than if there was some AI input.

The tool should be reliable enough (a command recognition rate above >95% and a maximum delay of 1 second for the display of the recognised command are initial acceptable values based on expert judgement) to enable ATCO to trust it and not having to check it all the time. If the ATCO would have to accept/reject the clearance recognition, workload and head-down time will not be reduced compared to the reference and waiting time will be introduced/increased. Reliability of the system should be further investigated in the next TRL6 phase, taking into account possible additional indicators (such as command error rate or time reduction for ATCo input into the system).

HP argument branch	Change & affected actors
	<p>ASR system provides a benefit mostly to a strip-environment and less to a stripless environment. Mainly it will depend on the integration. To achieve the workload benefits and the head-up benefits the integration of the system shall be complete and well performed.</p> <p>The solution might provide additional benefits in very large airports, so scope of the solution shall be extended to also address very large/large airports in the next project phase.</p> <p>ASR might be limited to not safety critical clearances.</p> <p>A switch-on/switch-off function is needed for ASR so that the function can be activated on request by ATCO.</p>
2.2 PERFORMANCE OF TECHNICAL SYSTEM	<p>The ASR support will improve system input performance, accuracy and timeliness thanks to the replacement of the manual input and interaction.</p> <p>The performance of ASR support might increase ATCO stress, frustration and decrease situational awareness, with consequent workload increase, in case the performance of the technical system are not as expected in terms of recognition rate (low recognition rate), time wait for the recognition output (e.g. need of continuously update wrongly recognised clearance, long time wait before showing the recognised clearance). This might also affect ATCO trust in the system.</p> <p>A huge database is needed for the ASR engine, and this is to be based on live data, not simulation data, including the different genders/accent of the target operating environment in order to target at least a 95% (initial acceptable value based on expert judgment to be further validated) recognition rate of all relevant English utterance, when the ontology is fully implemented.</p> <p>The ASR support might also introduce potential for overreliance on it, requiring evaluation in later stages of maturity assessment process.</p> <p>ASR should only be implemented with other existing tools for monitoring, such as conflicting clearance monitoring or safety nets.</p> <p>The system is not seen as easy to be implemented within the current system environment (e.g. EFPS) and thus deployment might not be easy. Potentially, more benefits of ASR might be achieved in the future deploying it at the same time of new systems.</p> <p>Change in HMI, hardware and software</p>

HP argument branch	Change & affected actors
2.3 HUMAN – MACHINE INTERFACE	<p>ASR tool will change input and output of ATCO devices: Automatic recognition of clearance will be displayed in the HMI and Automatic highlight of flight to be informed/cleared in the HMI will be provided. Voice communication instead of hardware (mouse/keyboard/digital pen) will be main change in terms of input device.</p> <p>These changes in the HMI might reduce the potential for human error: the HMI automatic highlight and clearance recognition might reduce potential error in CWP HMI interactions. Other HP indicators might also be improved:</p> <ul style="list-style-type: none"> • Workload might be reduced • Reducing head down time • Situational awareness might be improved by the: automatic highlight recalling attention on the flight to be cleared/informed • Usability might be improved improving user experience <p>On the other hand, decrease of situational awareness due to wrong highlighted callsign and potential of overreliance on the ASR tool support might happen</p>
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	No changes are expected in terms of team composition
3.2 ALLOCATION OF TASKS	No changes are expected in tasks allocation between human actors
3.3 COMMUNICATION	No changes are expected in communication among human actors (TWR and Cockpit) in terms of both means and phraseology, however, ATCOs might improve the adherence to the phraseology if they have a good user experience through ASR support
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	<p>ASR tool support might improve job acceptance and satisfaction in case of very good system performance but might also negatively affect both job acceptance and satisfaction in case of abnormal and degraded mode (malfunction) or low system performance (e.g. need of continuously update wrongly recognised clearance, long time wait before showing the recognised clearance).</p> <p>ASR input device increases job satisfaction by providing an interaction means that is intuitive (adherent to daily life user experience e.g. car speech recognition system, smartphone speech recognition systems).</p>
4.2 COMPETENCE REQUIREMENTS	No changes are expected in terms of competence requirements

HP argument branch	Change & affected actors
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	No changes are expected in terms of staffing levels and requirements
4.4. RECRUITMENT AND SELECTION	No changes are expected in terms of recruitment and selection
4.5. TRAINING NEEDS	Changes will be required in terms of content of training (even if not significant changes) as ATCOs will need to be trained on the new interaction (ASR) with systems, functionalities and system knowledge

Table 4: Description of the change

5.2 Step 2 Understand the HP implications

5.2.1 Relevant arguments, issues & benefits and HP activities

The next table provides the identified Relevant arguments, issues & benefits and HP activities for the solution PJ.05-W2-97.2.

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.	W2.PJ05.97-HP-V/A-R_TRL4_21	ISSUE/BENEFIT: Demand and fatigue might be reduced due to ATCO manual interaction reduction but might also increase due to ATCO being less involved and performing more monitoring than acting.	Open	PJ05.97 TRL4 TVALR/FINAL HP & SAF Workshop								
Arg. 1.3.5: Human actors can maintain a sufficient level of	W2.PJ05.97-HP-ASR-44	ASR system and functions affecting existing CWP systems and tools (e.g.	Open	PJ.05.97 HP&SAF Change &	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR	INDRA Navia / DLR / LDO	Real Time Simulation Workshop	CRT-05.972-TLR4-TVALP-H106-2016	Majority of ATCOs' responses (at least	SUMI/SUS/Tailor-Made Questionnaires/De briefing	EXE-05.97.2-TRL4-TVALP-ASR-004

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
situation awareness.		EFPS etc.) causing ATCO decrease in situation awareness and ability to accomplish tasks. This issue also affects arguments: Arg. 1.3.2: Tasks can be achieved in a timely manner. Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		Scoping Assessment		support the ATCOs in performing their tasks		Focus Group		75%) is that the level of usability is adequate when using ASR system		EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.	W2.PJ05 .97-HP- V/A- R_TRL4 _22	ASR Can also increase head-down time to check whether the system is registering and executing the right input (versus one-click input in reference situation). o ASR system provides a benefit mostly to a strip-environment and less to a stripless environment. Mainly it will depend on the integration. To achieve the workload benefits and the head-up benefits the integration of	Open	Final HP&SA F workshop								

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		the system shall be complete and well performed (the ASR main benefit would be highlighting the callsign from pilot utterance, in EFS environment, the ASR input would have to be integrated into the electronic flight strip)										
Arg. 2.1.2: Changes to the task allocation between human	W2.PJ05.97-HP-ASR-37	ASR failure to identify an aircraft and no aircraft is highlighted, decreasing	Open	PJ.05.97 HP&SAF Change &	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR	INDRA Navia / DLR / LDO	Real Time Simulation Workshop	CRT-05.972-TLR4-TVALP-H106-2012	Majority of ATCOs' responses (at least	SASHA / SART	EXE-05.97.2-TRL4-TVALP-ASR-004

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
and machine support human performance.		ATCO situation awareness and ATCO productivity (timely task execution) while ATCO is waiting for call sign highlight that does not happen: Consequent decrease of ATCO trust (frustration) /acceptance of ASR tool Lack of operating methods This issue also affects argument: Arg. 1.2.3: Operating methods cover		Scoping Assessment		support the ATCOs in performing their tasks		Focus Group		75%) is that the ASR supports ATCO in maintaining an adequate level of situation awareness		EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007



Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		degraded modes of the ATM system. Arg. 1.3.4: The level of trust in the new										

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		concept/the new procedures is appropriate. Arg. 2.1.2: Changes to the task allocation between human and machine support human performance. Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness. Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for							CRT-05.972-TLR4-TVALP-H106-2016	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using ASR system	SUMI/SUS/Tailor-Made Questionnaires/De briefing	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		carrying out the task.							CRT-05.972-TLR4-TVALP-H106-2011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using ASR Technology	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007
Arg. 2.1.2: Changes to the task allocation between human and machine support human	W2.PJ05.97-HP-V/A-R_TRL4_23	•BENEFIT: The automatic highlight and clearance recognition might reduce the potential for human error for the clearance input	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
performance.		and the flight selection										
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.	W2.PJ05.97-HP-V/A-R_TRL4_24	•BENEFIT: Usability might be improved improving user experience	Open									To be assessed in next phase
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human	W2.PJ05.97-HP-ASR-38	BENEFIT: ASR reduces workload suggesting ATCO command based on ATCO-Flight R/T. This might also affect	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR support the ATCOs in	INDRA Navia / DLR / LDO	Real Time Simulation Workshop Focus Group	CRT-05.972-TLR4-TVALP-H106-2011	Majority of ATCOs' responses (at least 75%) is that workload is	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
and the machine) is acceptable.		ATCO productivity and reduce head down time				performing their tasks				maintained at acceptable level when using ASR Technology		ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-ASR-42	ASR recognised command HMI integration in the CWP does not adhere to HF principles generating increasing in ATCO workload and decrease in situation awareness. This issue might also affects argument: Arg. 2.3.8: The user interface	Open	PJ.05.97 HP&SA F Change & Scoping Assessment	OBJ-05.972-TRL4-TVALP-H106-2010		INDRA Navia / DLR / LDO	Real Time Simulation Workshop Focus Group	CRT-05.972-TRL4-TVALP-H106-2011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using ASR Technology	NASA TLX / Bedford / ISA / Secondary Task / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		supports a sufficient level of individual situation awareness. [V1: AIR only]										
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-V/A-R_TRL4_25	If the ATCO would have to accept/reject the clearance recognition, workload will not be reduced compared to the reference and waiting time will be introduced/increased.	Open	Final HP&SAF workshop								
Arg. 2.1.4: The level of workload (induced by the	W2.PJ05.97-HP-ASR-45	Due to the late (delayed) ASR recognition and highlight of aircraft callsign the ATCO is	Open	PJ.05.97 HP&SAF Change &	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR	INDRA Navia / DLR / LDO	Real Time Simulation Workshop	CRT-05.972-TLR4-TVALP-H106-2016	Majority of ATCOs' responses (at least	SUMI/SUS/Tailor-Made Questionnaires/Debriefing	EXE-05.97.2-TRL4-TVALP-ASR-004

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
allocation of tasks between the human and the machine) is acceptable.		unable to complete his/her task efficiently (recognition rate, time wait for the recognition output); Consequent ATCO decrease in ASR tool trust/acceptance This issue also affects argument: Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable. Arg. 1.3.4: The		Scoping Assessment		support the ATCOs in performing their tasks		Focus Group		75%) is that the level of usability is adequate when using ASR system		EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		level of trust in the new concept/the new procedures is appropriate. Arg. 2.1.2: Changes to the task allocation between human and machine support human performance. Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors										

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		has been considered.										
Arg. 2.1.6: The level of trust in automated functions is appropriate.	W2.PJ05.97-HP-ASR-43	ASR command predictor forecasts possible future ATCO's command that is not relevant for the ATCO communication to pilot and proposes an ATC concept based on the utterance, which is not relevant for the communicated clearance,	Open	PJ.05.97 HP&SA F Change & Scoping Assessment	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR support the ATCOs in performing their tasks	INDRA Navia / DLR / LDO	Real Time Simulation Workshop Focus Group	CRT-05.972-TLR4-TVALP-H106-2017	Majority of ATCOs' responses (at least 75%) is that ASR acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		annoying ATCO that realizes the suggestion is not valid with a potential decrease of trust in the system. This issue might also affects argument: Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.							CRT- 05.972 -TRL4- TVALP -H106- 2015	Measured callsign recognition rate, command recognition rate, error rate and rejection rate of ASR system are considered within acceptable levels by the majority of ATCOS (at least 75%)	HErSA / Tailor- Made Questionnaires	EXE- 05.97.2- TRL4- TVALP- ASR- 004 EXE- 05.97.2- TRL4- TVALP- ASR- 006 EXE- 05.97.2- TRL4- TVALP- ASR- 007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.972-TLR4-TVALP-H106-2018	Majority of ATCOs' responses (at least 75%) is that the trust in the system is at an acceptable level	SATI	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007
Arg. 2.1.6: The level of trust in automated functions is appropriate.	W2.PJ05.97-HP-V/A-R_TRL4_26	•BENEFIT: Level of trust might be improved if the system has a high recognition rate	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05 .97-HP- V/A- R_TRL4 _27	•The performance of ASR support might increase ATCO stress, frustration and decrease situation awareness, with consequent workload increase, in case the performance of the technical system are not as expected in terms of recognition rate (low recognition rate), time wait for the recognition output	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05 .97-HP- V/A- R_TRL4 _28	•Potential for overreliance on ASR support	Open									To be assessed in next phase
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying	W2.PJ05 .97-HP- V/A- R_TRL4 _29	•ATCOs continuously need to check the system and thus no improvement in terms of workload reduction can be achieved	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
out the task.												
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R_TRL4_30	•ATCOs not realising if the pilot readback is not aligned with the given clearance	Open									To be assessed in next phase
Arg. 2.2.1: The accuracy and timeliness of information	W2.PJ05.97-HP-V/A-R_TRL4_31	•Latency of ASR not adequate causing ATCOs disturbance	Open									To be assessed in next phase



Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
n provided by the system is adequate for carrying out the task.												
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R_TRL4_32	•ASR using microphone and not robustly recognizing ATCOs instructions	Open									To be assessed in next phase



Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05 .97-HP- V/A- R_TRL4 _33	•ASR engine missing accents or female/male voice training providing worse performance	Open									To be assessed in next phase
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying	W2.PJ05 .97-HP- V/A- R_TRL4 _34	•ASR output speed not adequate for the ATCOs	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
out the task.												
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R_TRL4_35	•In case of non-recognition, double effort to manually recognize the error and correct it compared to pen input	Open									To be assessed in next phase
Arg. 2.3.3: Visual displays and other types of output devices	W2.PJ05.97-HP-V/A-R_TRL4_36	•Checking ASR output in the flight strip display might slow some ATCos, because	Open									To be assessed in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
adhere to HF principles. [V1: AIR only]		without ASR ATCos tick while speaking .										
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	W2.PJ05.97-HP-ASR-40	Wrong highlighted ASR callsign is not realised by ATCO with potential of Human Error increase: ATCO does not realize that the wrong callsign is highlighted and issues clearance to the wrong highlighted flight Consequent decrease of	Open	PJ.05.97 HP&SA F Change & Scoping Assessment	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR support the ATCos in performing their tasks	INDRA Navia / DLR / LDO	Real Time Simulation Workshop Focus Group	CRT-05.972-TLR4-TVALP-H106-2013	ASR does not increase the potential for human error	HErSA / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		situation awareness due to wrong highlighted callsign Potential of overreliance on the ASR tool support This issue also affects argument: Arg. 1.2.3: Operating methods cover degraded modes of the ATM system. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.3: The										

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		level of workload (induced by cognitive and/or physical task demands) is acceptable.										
									CRT-05.972-TLR4-TVALP-H106-2015	Measured call sign recognition rate, command recognition rate, error rate and rejection rate of ASR system are considered within acceptable levels	HErSA / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
										by the majority of ATCOS (at least 75%)		
									CRT-05.972-TLR4-TVALP-H106-2016	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using ASR system	SUMI/SUS/Tailor-Made Questionnaires/De briefing	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
									CRT-05.972-TLR4-TVALP-H106-2017	Majority of ATCOs' responses (at least 75%) is that ASR acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007
									CRT-05.972-TLR4-TVALP-H106-2014	Majority of ATCOs' responses (at least 75%) is that the level and quality	Observations / Customised questionnaire	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
										of information is adequate, complete and acceptable when using ASR Technology		006 EXE-05.97.2-TRL4-TVALP-ASR-007
									CRT-05.972-TRL4-TVALP-H106-2015	Measured call sign recognition rate, command recognition rate, error rate and rejection rate of ASR system	HErSA / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
										are considered within acceptable levels by the majority of ATCOS (at least 75%)		TVALP-ASR-007
									CRT-05.972-TLR4-TVALP-H106-2017	Majority of ATCOs' responses (at least 75%) is that ASR acceptance is adequate	CARS / Debriefing / Observations	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
												ASR-007
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]		BENEFIT: In case ATCo utter an incomplete/wrong callsign, it would be helpful the ASR system correct/complete it and in case a wrong clearance is issued other safety net shall intervene->	Open									
Arg. 2.3.7: The user interface design reduces human	W2.PJ05.97-HP-ASR-41	Wrong recognised ASR command is not realised by ATCO with potential of	Open	PJ.05.97 HP&SAF Change &	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR	INDRA Navia / DLR / LDO	Real Time Simulation Workshop	CRT-05.972-TLR4-TVALP-H106-2013	ASR does not increase the potential	HErSA / Tailor-Made Questionnaires	EXE-05.97.2-TRL4-TVALP-ASR-004

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
error as far as possible. [V1: AIR only]		Human Error increase: ATCO does not realizes the wrong command and the wrong command is automatically accepted by the system Potential of overreliance on the ASR tool support Consequent decrease of situation awareness and increase in human error This issue also affects argument: Arg. 1.2.3: Operating methods cover		Scoping Assessment		support the ATCOs in performing their tasks		Focus Group		I for human error		EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity/ ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
		degraded modes of the ATM system. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.										
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness	W2.PJ05.97-HP-ASR-39	BENEFIT: ASR increases situation awareness highlighting callsign based on ATCO-Flight R/T. This might also	Open	PJ.05.97 HP&SAF Change & Scoping Assessment	OBJ-05.972-TRL4-TVALP-H106-2010		INDRA Navia / DLR / LDO	Real Time Simulation Workshop Focus Group	CRT-05.972-TRL4-TVALP-H106-2012	Majority of ATCOs' responses (at least 75%) is that the ASR	SASHA / SART	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
s. [V1: AIR only]		affect ATCO productivity								support s ATCO in maintai ning an adequat e level of situatio n awareness		TVALP- ASR- 006 EXE- 05.97.2- TRL4- TVALP- ASR- 007
Arg. 3.3.1: Intra-team and inter- team communication supports the informatio n requireme nts of team members.	W2.PJ05 .97-HP- V/A- R_TRL4 _37	BENEFIT: ATCOs might improve the adherence to the phraseology if they have a good user experience through ASR support	Open									To be assesse d in next phase

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.	W2.PJ05.97-HP-V/A-R_TRL4_38	•Job acceptance and satisfaction might be reduced in case of abnormal and degraded mode (malfunction) or low system performance (e.g. need of continuously update wrongly recognised clearance, long time wait before showing the recognised clearance)	Open									To be assessed in next phase
Arg. 4.1.2: The impact of changes on the job satisfaction	W2.PJ05.97-HP-ASR-46	BENEFIT: ASR input device increases job satisfaction by providing an interaction	Open	PJ.05.97 HP&SAF Change &	OBJ-05.972-TRL4-TVALP-H106.2030	To assess job acceptance and satisfaction	INDRA Navia / DLR / LDO	Real Time Simulation Workshop	CRT-05.972-TRL4-TVALP-H106-2031	Majority of ATCOs' responses (at least	CARS / Debriefing / Observations	EXE-05.97.2-TRL4-TVALP-ASR-004

Argument	HP issue/ benefit ID	HP issue / benefit	Status	Source	HP/ validation on objectives ID	Objectives	Addressed by (project member (s))	HP activity /ies	Success criteria ID	Success Criteria	Method	Scenarios/ events in case of SESAR exercise
n of affected human actors has been considered.		means that is intuitive (adherent to daily life user experience e.g. car speech recognition system, smartphone speech recognition systems). This might also affect argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]		Scoping Assessment		on with the introduction of ASR		Focus Group		75%) is that job satisfaction and acceptance is adequate when using ASR		EXE- 05.97.2- TRL4- TVALP- ASR- 006 EXE- 05.97.2- TRL4- TVALP- ASR- 007

Table 5 ASR Relevant arguments, issues & benefits and HP activities

6 HP Objectives and Success criteria summary

SoL	OBJID	OBJ Title	SCID	Success Criteria
Sol 1	OBJ-05.971-TRL4-TVALP-H103.1010	To assess that the technical systems for V/A-R Tracking labels and overlays support the ATCOs in performing their tasks	CRT-05.971-TRL4-TVALP-H103-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Technology
			CRT-05.971-TRL4-TVALP-H103-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Technology
			CRT-05.971-TRL4-TVALP-H103-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness
			CRT-05.971-TRL4-TVALP-H103-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario
			CRT-05.971-TRL4-TVALP-H103-1015	HMI of V/A-R tools does not overshadow the relevant information on the OTW view
			CRT-05.971-TRL4-TVALP-H103-1016	V/A-R HMI does not increase the potential for human error

			CRT-05.971-TLR4-TVALP-H1033-1017	Majority of ATCOs' responses (at least 75%) is that the trust in the system is at an acceptable level
			CRT-05.971-TLR4-TVALP-H103-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R HMI
			CRT-05.971-TLR4-TVALP-H103-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the early detection of ATC critical situations
			CRT-05.971-TLR4-TVALP-H103-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R acceptance is adequate
			CRT-05.971-TLR4-TVALP-H103-1021	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO team (GND and TWR) in maintaining an acceptable level of situation awareness
Sol 1	OBJ-05.971-TLR4-TVALP-H103.1030	To assess that the role of the ATCO is consistent with human capabilities and limitations with the introduction of V/A-R Tracking labels and overlays	CRT-05.971-TLR4-TVALP-H103-1031	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using V/A-R
			CRT-05.971-TLR4-TVALP-H103-1032	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly

				identified and consistent in all operating conditions when using V/A-R
Sol 1	OBJ-05.971-TRL4-TVALP-H103.1040	To assess job acceptance and satisfaction with the introduction of V/A-R Tracking labels and overlays	CRT-05.971-TRL4-TVALP-H103-1041	Majority of ATCOs' responses (at least 75%) is that job satisfaction and acceptance is adequate when using V/A-R
Sol 1	OBJ-05.971-TRL4-TVALP-H104.1010	To assess that the technical systems for V/A-R Air Gestures support the ATCOs in performing their tasks	CRT-05.971-TRL4-TVALP-H104-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Air Gestures Technology
			CRT-05.971-TRL4-TVALP-H104-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Air Gestures Technology
			CRT-05.971-TRL4-TVALP-H104-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Air Gestures HMI supports ATCO in maintaining an adequate level of situation awareness
			CRT-05.971-TRL4-TVALP-H104-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario
			CRT-05.971-TRL4-TVALP-H104-1015	V/A-R Air Gestures HMI does not increase the

				potential for human error
			CRT-05.971-TLR4-TVALP-H104-1016	Majority of ATCOs' responses (at least 75%) is that the trust in the system is at an acceptable level
			CRT-05.971-TLR4-TVALP-H104-1017	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using V/A-R Air Gestures HMI
			CRT-05.971-TLR4-TVALP-H104-1018	Majority of ATCOs' responses (at least 75%) is that V/A-R Air Gestures acceptance is adequate
Sol 1	OBJ-05.971-TLR4-TVALP-H104.1020	To assess that the role of the ATCO is consistent with human capabilities and limitations with the introduction of V/A-R Air Gestures	CRT-05.971-TLR4-TVALP-H104-1021	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using V/A-R Air Gesture
			CRT-05.971-TLR4-TVALP-H104-1022	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly identified and consistent in all operating conditions when using V/A-R Air Gesture
Sol 1	OBJ-05.971-TLR4-TVALP-H104.1030	To assess job acceptance and satisfaction with the introduction of V/A-R Air Gestures	CRT-05.971-TLR4-TVALP-H104-1031	Majority of ATCOs' responses (at least 75%) is that job satisfaction and acceptance is adequate when using V/A-R Air Gesture

Sol 1	OBJ-05.971-TRL4-TVALP-H105.1010	To assess that the technical systems for V/A-R Attention Guidance support the ATCOs in performing their tasks	CRT-05.971-TRL4-TVALP-H105-1011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using V/A-R Attention Guidance Technology
			CRT-05.971-TRL4-TVALP-H105-1012	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using V/A-R Attention Guidance Technology
			CRT-05.971-TRL4-TVALP-H105-1013	Majority of ATCOs' responses (at least 75%) is that the V/A-R Attention Guidance HMI supports ATCO in maintaining an adequate level of situation awareness
			CRT-05.971-TRL4-TVALP-H105-1014	Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario
			CRT-05.971-TRL4-TVALP-H105-1015	HMI of V/A-R Attention Guidance tools does not overshadow the relevant information on the OTW view
			CRT-05.971-TRL4-TVALP-H105-1016	V/A-R Attention Guidance HMI does not increase the potential for human error
			CRT-05.971-TRL4-TVALP-H105-1017	Majority of ATCOs' responses (at least 75%) is that the trust in the system

				is at an acceptable level
			CRT-05.971-TLR4-TVALP-H105-1018	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using Attention Guidance HMI
			CRT-05.971-TLR4-TVALP-H105-1019	Majority of ATCOs' responses (at least 75%) is that the alarms and alerts are not too intrusive and support ATCOs in the early detection of ATC critical situations
			CRT-05.971-TLR4-TVALP-H105-1020	Majority of ATCOs' responses (at least 75%) is that V/A-R Attention Guidance acceptance is adequate
			CRT-05.971-TLR4-TVALP-H105-1021	Majority of ATCOs' responses (at least 75%) is that the V/A-R HMI supports ATCO team (GND and TWR) in maintaining an acceptable level of situation awareness
Sol 1	OBJ-05.971-TLR4-TVALP-H105.1030	To assess that the role of the ATCO is consistent with human capabilities and limitations with the introduction of V/A-R Attention Guidance	CRT-05.971-TLR4-TVALP-H105-1031	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using V/A-R Attention Guidance
			CRT-05.971-TLR4-TVALP-H105-1032	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly

				identified and consistent in all operating conditions when using V/A-R Attention Guidance
Sol 1	OBJ-05.971-TRL4-TVALP-H105.1040	To assess job acceptance and satisfaction with the introduction of V/A-R Attention Guidance	CRT-05.971-TRL4-TVALP-H105-1041	Majority of ATCOs' responses (at least 75%) is that job satisfaction and acceptance is adequate when using V/A-R Attention Guidance
Sol 2	OBJ-05.972-TRL4-TVALP-H106.2010	To assess that the technical systems for ASR support the ATCOs in performing their tasks	CRT-05.972-TRL4-TVALP-H106-2011	Majority of ATCOs' responses (at least 75%) is that workload is maintained at acceptable level when using ASR Technology
			CRT-05.972-TRL4-TVALP-H106-2012	Majority of ATCOs' responses (at least 75%) is that the ASR supports ATCO in maintaining an adequate level of situation awareness
			CRT-05.972-TRL4-TVALP-H106-2013	ASR does not increase the potential for human error
			CRT-05.972-TRL4-TVALP-H106-2014	Majority of ATCOs' responses (at least 75%) is that the level and quality of information is adequate, complete and acceptable when using ASR Technology
			CRT-05.972-TRL4-TVALP-H106-2015	Measured callsign recognition rate, command recognition rate, error rate and rejection rate of ASR system are considered within

				acceptable levels by the majority of ATCOS (at least 75%)
			CRT-05.972-TLR4-TVALP-H106-2016	Majority of ATCOs' responses (at least 75%) is that the level of usability is adequate when using ASR system
			CRT-05.972-TLR4-TVALP-H106-2017	Majority of ATCOs' responses (at least 75%) is that ASR acceptance is adequate
			CRT-05.972-TLR4-TVALP-H106-2018	Majority of ATCOs' responses (at least 75%) is that the trust in the system is at an acceptable level
Sol 2	OBJ-05.972-TLR4-TVALP-H106.2020	To assess the role of the ATCO is consistent with human capabilities and limitations with the introduction of ASR	CRT-05.972-TLR4-TVALP-H106-2021	Majority of ATCOs' responses (at least 75%) is that they can apply operating methods in an accurate, efficient and timely manner when using ASR
			CRT-05.972-TLR4-TVALP-H106-1022	Majority of ATCOs' responses (at least 75%) is that operating methods are clearly identified and consistent in all operating conditions when using ASR
Sol 2	OBJ-05.972-TLR4-TVALP-H106.2030	To assess job acceptance and satisfaction with the introduction of ASR	CRT-05.972-TLR4-TVALP-H106-2031	Majority of ATCOs' responses (at least 75%) is that job satisfaction and acceptance is adequate when using ASR

Table 6: Summary of HP objectives & success criteria

7 Summary of HP tools and simulation Log/metrics

The following table summarises the selected tools for the assessment of the different indicators for each validation exercise:

	EXE- 05.97.1- TRL4- TVALP- VAR-001	EXE- 05.97.1- TRL4- TVALP-VAR- 002	EXE- 05.97.1- TRL4- TVALP-VAR- 005	EXE- 05.97.2- TRL4- TVALP-ASR- 004	EXE- 05.97.2- TRL4- TVALP-ASR- 006	EXE- 05.97.2- TRL4- TVALP-ASR- 007
Workload	NASA TLX (possibly ISA)	Bedford (+ customized quest)	NASA-TLX	Not Addressed	NASA-TLX, ISA, Bedford, Secondary Task	Bedford (+ customized quest)
Situation awareness	SASHA or SART	Chinal lake (+ customised questions)	SASHA	Not Addressed	SASHA	SASHA
Acceptabil ity	CARS or SATI	CARS	Debriefing	Not Addressed	CARS	CARS
Usability	SUMI or SUS	SUS	SUS	SATI, Tailor- Made Questionnai res	SUS	SUS
Trust	CARS or SATI	SATI	SATI	SATI	SATI	SATI
Human Error	HErSA (NLR inhouse develope d Human Error assessme nt	Tailor-Made Questionnai res	Tailor-Made Questionnai res	Not Addressed	Tailor-Made Questionnai res	Tailor-Made Questionnai res

	technique)					
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Table 7: Table of proposed HP tools

The following table summarises the selected simulation data log for the assessment of the different indicators/metrics for each validation exercise:

Solutions	Metrics	Indicators
PJ.05.97.01	Head Down/Head Up	Duration Number of Switches
PJ.05.97.01 PJ.05.97.02	ATCOs order	Number and type of ATCOs clearances issued
PJ.05.97.02	ASR Recognition Rate	-callsign recognition rate; callsign recognition error rate; -callsign recognition rejection rate -command recognition rate; command recognition error rate; command recognition rejection rate -back to manual /manual correction -ASR usage rate

Table 8: Table of proposed HP sim data log and indicators

8 Step 3 Improve and validate the concept

8.1 Description of HP activities conducted

The following tables summarises the conducted validation activities.

HP activity #	HP activity title	By when
Activity 1.	ASR HP and SAF workshop	09/07/2020
Activity 2.	V/A-R HP and SAF workshop	22/07/2020
Activity 3.	HP Post-simulations V/A-R workshop	04/07/2022
Activity 4.	HP Post-simulations ASR workshop	05/07/2022
Activity 5.	V/A-R HP Requirements workshop	04/07/2022
Activity 6.	ASR Requirements workshop	05/07/2022
Activity 7.	EXE-05.97.1-TRL4-TVALP-VAR-001	Q3 2021
Activity 8.	EXE-05.97.1-TRL4-TVALP-VAR-002	Q4 2021
Activity 9.	EXE-05.97.1-TRL4-TVALP-VAR-005	Q2 2022
Activity 10.	EXE-05.97.2-TRL4-TVALP-ASR-004	Q4 2021
Activity 11.	EXE-05.97.2-TRL4-TVALP-ASR-006	Q3 2021
Activity 12.	EXE-05.97.2-TRL4-TVALP-ASR-007	Q2 2022

Table 9: Table of proposed HP activities and their priority

The following tables summarises provides the description of each conducted activity.

ACTIVITY 1.	ASR HP and SAF workshop
Description	Workshop
HP OBJECTIVES	<p>HP and Safety scoping and change assessment</p> <p>Identify / update human actors likely to be impacted by the change & assess changes in Arg. 1. Roles & Responsibilities; Arg. 2. Human & System; Arg. 3. Teams & Communication Arg. 4. HP related Transition Factors.</p> <p>Identify/update HP issues and benefits</p>

Tool selected out of the HP repository	Structured Walkthrough
summary of the hp activity	Description of reference scenario; description of Solution Scenario; Identification of affected arguments; Table of changes for affected argument; Identifications of HP Issues and Benefits s

Table 10: Description of Activity 1

ACTIVITY 2.	V/A-R HP and SAF workshop
Description	Workshop to integrate and consolidate HP solution results
HP OBJECTIVES	<p>HP and Safety scoping and change assessment</p> <p>Identify / update human actors likely to be impacted by the change & assess changes in Arg. 1. Roles & Responsibilities; Arg. 2. Human & System; Arg. 3. Teams & Communication Arg. 4. HP related Transition Factors.</p> <p>Identify/update HP issues and benefits</p>
Tool selected out of the HP repository	Structured Walkthrough
summary of the hp activity	Description of reference scenario; description of Solution Scenario; Identification of affected arguments; Table of changes for affected argument; Identifications of HP Issues and Benefits s

Table 11: Description of Activity 2

ACTIVITY 3.	HP Post-simulations ASR workshop
Description	Workshop to integrate and consolidate HP solution results
HP OBJECTIVES	Review and integration of HP solution results
Tool selected out of the HP repository	Focus group
summary of the hp activity	Identification and discussion of the results for the previous identified issues

Table 12: Description of Activity 3

ACTIVITY 4.	HP Post-simulations V/A-R workshop
Description	Workshop to integrate and consolidate HP solution results
HP OBJECTIVES	Review and integration of HP solution results
Tool selected out of the HP repository	Workshop involving end users
summary of the hp activity	Identification and discussion of the results for the previous identified issues

Table 13: Description of Activity 4

ACTIVITY 5.	ASR HP Requirements workshop
Description	Workshop to consolidate HP requirements and remove potential duplication with safety requirements
Tool selected out of the HP repository	Workshop involving end users
HP OBJECTIVES	Consolidation of HP requirements
summary of the hp activity	Possible mitigations identifications and discussions for the identified issues

Table 14: Description of Activity 5

ACTIVITY 6.	V/A-R HP Requirements workshop
Description	Workshop to consolidate HP requirements and remove potential duplication with safety requirements
HP OBJECTIVES	Consolidation of HP requirements
Tool selected out of the HP repository	Workshop involving end users
Summary of the hp activity	Possible mitigations identifications and discussions for the identified issues

Table 15: Description of Activity 6

ACTIVITY 7.	EXE-05.97.1-TRL4-TVALP-VAR-001
Description	Simulation to establish whether the attention-guidance symbology offered via HoloLens (AR) has a positive effect on ATCOs ability to identify relevant situations during nominal and certain non-nominal operations at Schiphol airport. Poor visibility and freezing of the system were simulated.
HP OBJECTIVES	<p>OBJ-05.971-TRL4-TVALP- H105.1010</p> <p>OBJ-05.971-TRL4-TVALP- H105.1030</p> <p>OBJ-05.971-TRL4-TVALP- H105.1040</p>
Tool selected out of the HP repository	<ul style="list-style-type: none"> • Workload: NASA TLX (possibly ISA) • Situational Awareness: SASHA or SART • Acceptability/Trust: CARS or SATI • Usability: SUMI or SUS • Post Run dedicates questionnaire and debrief procedure, including discussion on SA / acceptability / workload
Summary of the hp activity	<p>Two ATCOs participated in this study. The study was executed in NLR's high fidelity Human-in-the-Loop real time simulation environment called NARSIM. A randomised design was chosen, ensuring that participants went through the scenarios each in a different order. Further each participant executed the same type of events with and without AR-device (HoloLens). Three different attention guidance scenarios, or events, took place: RWY Incursion Alert, Go Around warning, and a TWY Conflict Alert. Since this was an initial study to verify whether the concept is realistic and feasible, the scale of the trials was kept relatively small. The tools from the repository where applied, but also during the trials, the breaks and the debriefing session observations and remarks were noted down. Results were reported in the SESAR Sol97 TVALR. Note though that the scale of the experiment was too small for thorough statistical analyses. The aim of the study was primarily to verify the feasibility and list the first items to work on for developers regarding the use of AR devices in the tower.</p>

Table 16: Description of Activity 7

ACTIVITY 8.	EXE-05.97.1-TRL4-TVALP-VAR-002
Description	Real Time simulation addressing Virtual/Augmented Reality Tower Tools, Tracking Labels and Air Gesture Interaction at Bologna Airport

Related Arguments	See HP-Log
HP OBJECTIVES	CRT-05.971-H103-1011/ CRT-05.971-H103-1012 / CRT-05.971-H103-1013 / CRT-05.971-H103-1014 / CRT-05.971-H103-1015 / CRT-05.971-H103.1016 / CRT-05.971-H103-1017 / CRT-05.971-H103-1018 / CRT-05.971-H103-1019 / CRT-05.971-H103-1020 / CRT-05.971-H103-1021 / CRT-05.971-H103-1031 / CRT-05.971-H103-1032 / CRT-05.971-H103-1041 / CRT-05.971-H104-1011 / CRT-05.971-H104-1013 / CRT-05.971-H104-1014 / CRT-05.971-H104-1016 / CRT-05.971-H104-1017 / CRT-05.971- H104-1018 / CRT-05.971-H104-1021 / CRT-05.971-H104-1022 / CRT-05.971-H104-1031
Issues to be addressed / investigated from issues analysis	See HP-Log
Tool selected out of the HP repository	<ul style="list-style-type: none"> • Workload: Bedford (+ customized quest, NASA-tlx) • Situation awareness: SASHA • Acceptability: CARS • Usability: SUS • Trust: SATI • Human Error: Tailor-Made Questionnaires • Debriefings: Post Exercise Debriefing/Post Simulation Final Debriefing
summary of the hp activity	See HP-Log

Table 17: Description of Activity 8

ACTIVITY 9.	EXE-05.97.1-TRL4-TVALP-VAR-005
Description	Shadow mode simulation (EXE-005)
Related Arguments	See HP-Log
HP OBJECTIVES	OBJ-05.971-TRL4-TVALP-H103.1010; OBJ-05.971-TRL4-TVALP-H103.1030; OBJ-05.971-TRL4-TVALP-H103.1040; OBJ-05.971-TRL4-TVALP-H104.1010; OBJ-05.971-TRL4-TVALP-H1043.1020; OBJ-05.971-TRL4-TVALP-H104.1030;
Issues to be addressed / investigated from issues analysis	See HP-Log
Tool selected out of the HP repository	<ul style="list-style-type: none"> • Workload: NASA-TLX • Situation awareness: SASHA • Acceptability: Debriefing

	<ul style="list-style-type: none"> • Usability: SUS • Trust: SATI • Human Error: Tailor-Made Questionnaires
summary of the hp activity	See HP-Log

Table 18: Description of Activity 9

ACTIVITY 10.	EXE-05.97.2-TRL4-TVALP-ASR-004
Description	<p>Validation exercise- Real Time Simulation (Indra and HC)</p> <p>The RTS validation exercise (EXE-05.972-TRL4-TVALP-004) will investigate the benefits of the ASR technology, using HungaroControl's and Indra's system. The functions using the new technology will be adapted to the real time simulator system. The part of the validation exercise with its main focus on ASR will take place in December 2021 at Asker.</p>
Related Arguments	See HP-Log
HP OBJECTIVES	To assess that the technical systems for ASR support the ATCOs in performing their tasks
Issues to be addressed / investigated from issues analysis	See HP-Log
Tool selected out of the HP repository	<ul style="list-style-type: none"> • Workload: Bedford • Situation awareness: SASHA • Acceptability : Debriefing • Usability: SATI, Tailor-Made Questionnaires • Trust: SATI • Human Error: Tailor-Made Questionnaires
Summary of the hp activity	See HP-Log

Table 19: Description of Activity 10

ACTIVITY 11.	EXE-05.97.2-TRL4-TVALP-ASR-006
Description	The human performance effects of an assistant-based speech recognition system to support multiple remote tower controllers in their work will be analyzed. More specifically, the callsign highlighting and command recognition

	output as input for the ATC system should support the ATCO work (to be validated).
Related Arguments	See HP-Log
HP OBJECTIVES	Assessment of workload (reduction), situation awareness (increase), acceptance of and performance with the assistant-based speech recognition system.
Issues to be addressed / investigated from issues analysis	See HP-Log
Tool selected out of the HP repository	Workload: NASA-TLX, ISA, Bedford, Secondary Task Situation awareness: SASHA Acceptability: CARS Usability: SUS Trust: SATI Human Error: Tailor-Made Questionnaires
Summary of the hp activity	See HP-Log

Table 20: Description of Activity 11

ACTIVITY 12.	EXE-05.97.2-TRL4-TVALP-ASR-007
Description	<p>Integration of a speech recognition system in a next-gen CWP in order to achieve operational goals:</p> <ul style="list-style-type: none"> assistance to ATCO by prefiling an appropriate system mask (containing highlighted callsign information, clearances, orders and parameters, updated according to ATCO instructions) using verbal communication contents. <p>The validation exercise simulated operation at the Sofia airport.</p>
Related Arguments	See HP-Log
HP OBJECTIVES	<ul style="list-style-type: none"> To assess the role of the ATCO is consistent with human capabilities and limitations with the introduction of ASR To assess that the technical systems for ASR support the ATCOs in performing their tasks To assess job acceptance and satisfaction with the introduction of ASR

Issues to be addressed / investigated from issues analysis	See HP-Log
Tool selected out of the HP repository	<p>Appraisal of workload reduction, improvement of situation awareness; evaluation of approval and adoption of ASR systems. Assessment of overall performance impact determined by ASR system adoption, potential for human error.</p> <ul style="list-style-type: none"> • Workload: Bedford (+ customized quest) • Situation awareness: SASHA • Acceptability: CARS • Usability: SUS • Trust: SATI • Human Error: Tailor-Made Questionnaires • Performance: Custom questionnaire • Post Run questionnaire tailored to Exercise
summary of the hp activity	See HP-Log

Table 21: Description of Activity 12

9 Step 4 Collate findings & conclude on transition to TRL6-phase

9.1 Summary of HP activities results & recommendations / requirements

The following table provides the Summary of HP activities results & recommendations / requirements for solution PJ.05-W2-97.1.

Even if some of the validation exercises results are not directly mentioned in the table, all the validation activities have been taken into account for the requirements and recommendations definition as all the validation exercises report was used to prepare the post simulation workshops and they were represented to provide subjective feedback at the final and post simulation workshop.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.	W2.PJ05.97-HP-V/A-R-59	Operating methods with the introduction of V/A-R tracking labels, V/A-R air gestures and V/A-R attention guidance are not clearly identified for normal, abnormal and degraded mode conditions, negatively affecting trust in the new technology	OBJ-05.971-TRL4-TVALP-H103.1030	CRT-05.971-TLR4-TVALP-H103-1031	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that ATCOs can apply operating methods in an accurate, efficient and timely manner.		Operating methods for V/A-R shall be established for normal, abnormal and degraded mode
				CRT-05.971-TLR4-TVALP-H103-1032	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	Only 50% of the ATCOs' responses indicated that operating methods are clearly identified and consistent in the investigated operating conditions.		
				CRT-05.971-TLR4-TVALP-H104-1021	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	No specific impacts of Air Gesture on		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				CRT-05.971-TLR4-TVALP-H104-1022	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	operation methods were mentioned by the ATCOs. 90% and 80% of ATCOs responded that their trust in the prototype for V/AR and V/AR Air Gestures, respectively, is at an acceptable level.		
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.		Head-up display of conflict improving user experience not having to search for information about where the conflict is and which a/c (call signs) are involved				To be assessed in next phase	V/A-R Head-up display may provide alerts for conflicting aircraft	
Arg. 1.2.4: The content of operating methods is clear and consistent (in V1: non-contradictory).	W2.PJ05.97-HP-V/A-R-9	Failure of V/A-R Tracking label requires ATCO to recover to current operating methods with a consequent decrease in situation awareness and a lack in the operating methods if failure recovery operational procedures are not described. This might negatively affect ATCO productivity The issue also affects	OBJ-05.971-TRL4-TVALP-H103.1030	CRT-05.971-TLR4-TVALP-H103-1031	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that ATCOs can apply operating methods in an accurate, efficient and timely manner.		Recovery operating procedures shall be defined in case of failure of V/A-R in all operating conditions
				CRT-05.971-TLR4-TVALP-H103-1032	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	Only 50% of the ATCOs' responses indicated that operating methods are clearly identified and consistent in the investigated		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]				operating conditions. 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-V/A-R-29	V/A-R attention guidance visual cues is only visible from specific angles and ATCO needs to frequently turn the head to recognise the alert, causing increase of workload and affecting usability. This issue also affects argument:	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - This was not considered a problem The cue clearly indicated where to look, and ATCOs actually wanted to look there as soon as the alarm sounded. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
		Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]		CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. In fact the guidance supports SA, the angles or need to turn a head was considered to negatively influence SA See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		The Attention Guidance alerts shall be visible from all the angles in the tower.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				CRT-05.971-TLR4-TVALP-H105-1011	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - WL was not significant higher for the AR condition compared to the baseline condition. And in both conditions acceptable. No simlog or other (digital) indicators were recorded. Here as well the fact that the head needs to turn in order to follow the cue was not considered a factor to increase mental workload. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - Usability in general was rated just a bit below 50%. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.1.4: The level of workload (induced by the	W2.PJ05.97-HP-V/A-R-30	V/A-R attention guidance visual cues guiding the ATCO's gaze on a safety critical event is only	OBJ-05.971-TRL4-TVALP-	CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 104		The Attention Guidance system shall identify the operator's attention focus

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
allocation of tasks between the human and the machine) is acceptable.		visible from specific angles and ATCO needs to frequently turn the head to recognise the direction where the attention is required alert, causing increase of workload and affecting usability. This might also affects safety This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	H105.1010					on the airport traffic situation.
				CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 105		The Attention Guidance system shall adapt and/or trigger the display of visual elements on the situation data display to the controller.
				CRT-05.971-TLR4-TVALP-H105-1011	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 106		
				CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 107		
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-12	V/A-R Tracking label does not provide adequate information (e.g. latest updated information; needed information) and ATCO is not supported by the HMI for the needed information, negatively	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on		The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		affecting situation awareness, human error, ability to accomplish tasks and focus on primary tasks. This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]				the quality of the information.		and initial climbing path.
				CRT-05.971-TLR4-TVALP-H103-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS.		The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		Tracking labels displayed in the Head-Up HMI shall not overlap between each others
				CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-	EXE02 - At least 75% of the ATCOs confirmed that the system is easy to		The V/AR system shall indicate the depth of the

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				H103-1018	TRL4-TVALP-VAR-005	use (80%), that the interface was clear and complete (80%), that there was not too much inconsistency and that the device is physically comfortable (80%). However, less than 75% of the ATCOs confirmed that they would like to use the system frequently (50%), that they imagine most people can learn to use the system very quickly (70%), that they felt confident using the system (70%), that there was not too much inconsistency (40%) and the device did not cause any negative physical consequences like eyestrain (70%).		real object by its presentation as part of the conformal information associated to it.
Arg. 2.2.1: The accuracy and timeliness of information provided by	W2.PJ05.97-HP-V/A-R-8	Tracking label of V/A-R is detached (e.g. is frozen or not aligned) from the relevant object (aircraft/vehicles)	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided		Tracking labels displayed in the Head-Up HMI shall not overlap

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
the system is adequate for carrying out the task.		causing confusion and annoyance to ATCO with a possible decrease in situation awareness, job acceptance and satisfaction and a possible increase in workload and potential for human error. This might negatively affect ATCO productivity. The issue also affects arguments: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness. Arg. 1.3.3: The level of		H103-1012	TRL4-TVALP-VAR-005	by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information. 90% of ATCOs responses indicated that the prototype for V/AR supports ATCOs in maintaining an acceptable level of workload. Only 50% of the ATCOs agreed that the tracking label and the airport overlay provided by V/A-R were adequate and did not generate confusion neither disturbance. ATCOs commented that the		between each others
						the labels were overlapping and covering the background and that they were sometimes badly aligned. 80% of the ATCOs agreed that		The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.
								The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.
				CRT-05.971-TLR4-TVALP-H103-1011	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005			The V/AR system shall display a visual indication of the limit of the augmented reality field of view in the

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		workload (induced by cognitive and/or physical task demands) is acceptable.				they always had an adequate field of view when using the V/A-R system to perform their task. 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness. Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS. 85% of ATCOs' responses indicated		Head-up display.
				CRT-05.971-TLR4-TVALP-H103-1015	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005			The V/AR system shall not display tracking labels for not active traffic in the Head-up display.
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005			Algorithm shall support smooth movement of real-time data labels

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						an acceptable level of job satisfaction regarding the prototype for V/AR tracking labels and overlays.		
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-15	V/A-R Tracking label different views from different angles confuse or mislead ATCO with potential increase in human error and decrease of situation awareness and negatively affecting the ability to accomplish tasks. This issue also affects argument: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1020	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 80% of ATCOs' responses indicated an adequate level of acceptance of the V/A-R tool. Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS. All ATCOs agreed that the V/A-R HMI		The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.
								The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.
				CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-			Tracking labels displayed in the Head-Up HMI shall not overlap

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				H103-1016	TRL4-TVALP-VAR-005	supports ATCO team in maintaining a sufficient level of situation awareness. 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R.		between each others
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.	W2.PJ05.97-HP-V/A-R-20	V/A-R system and functions affecting existing CWP systems and tools causing ATCO decrease in situation awareness and ability to accomplish tasks. This issue also affects arguments: Arg. 1.3.2: Tasks can be achieved in a timely manner. Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		The V/AR system shall not obstruct the natural field of view of the ATCO with augmented reality elements.
								Tracking labels shall not be considered as primary source of information
								The V/AR system shall be able to avoid cluttering of synthetic overlays that may obstruct the real view or overlap with



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
								other information.
				CRT- 05.971- TLR4- TVALP- H103- 1018	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - At least 75% of the ATCOs confirmed that the system is easy to use (80%), that the interface was clear and complete (80%), that there was not too much inconsistency and that the device is physically comfortable (80%). However, less than 75% of the ATCOs confirmed that they would like to use the system frequently (50%), that they imagine most people can learn to use the system very quickly (70%), that they felt confident using the system (70%), that there was not too much inconsistency (40%) and the device did not cause any negative physical	Acceptability of V/A-R system should be further assessed	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						consequences like eyestrain (70%). To be assessed in next phase		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system causes heavy head due to the weight of the head device				To be assessed in next phase	Usability of V/A-R systems should be further assessed	
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system head device causes reflections of surrounding light and the reflection is also worst in combination with personal glasses				To be assessed in next phase	Usability of V/A-R systems should be further assessed	
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-21	BENEFIT: V/A-R air gesture interaction reduces workload replacing a CWP head down interaction with a smart and head-up interaction means. This might also affects ATCO productivity	OBJ- 05.971- TRL4- TVALP- H104.1010	CRT- 05.971- TLR4- TVALP- H104- 1011	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - Only 40% of ATCOs' responses is that V/A-R Air Gestures supports ATCO in maintaining workload at acceptable level. Several ATCOs had difficulties using Air Gestures which increased their workload.	Usability of V/A-R Air Gesture systems should be improved and further assessed	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				CRT-05.971-TLR4-TVALP-H104-1014	EXE-05.97.1-TRL4-TVALP-VAR-002	EXE02 - Measured time spent in head-up is increased in the Air Gesture solution scenario with respect to the reference scenario.		
				CRT-05.971-TLR4-TVALP-H104-1017	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 20% of the ATCOs responded that the V/A-R Air Gestures have no impact on the usability whereas the other 80% believes that usability is negatively impacted, mostly from an ergonomic point of view.		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R air gestures not intuitive				To be assessed in next phase	Usability of V/A-R Air Gesture systems should be improved and further assessed	
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch		•Benefit: ATCO reaction times decrease with V/A-R TL				To be assessed in next phase	V/A-R Head-up display may provide alerts for	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
screen) correspond to HF principles. [V1: AIR only]							runway incursion	
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system causes heavy head due to the weight of the head device and not usable during an entire shift				To be assessed in next phase		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system head device causes reflections of surrounding light and the reflection is also worst in combination with personal glasses				To be assessed in next phase		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•Attention guidance providing algorithm not advanced causing nuisance alerts (e.g. alerts for taxi conflict displayed to TWR ATCO not responsible of it, alert notice disappearing when facing the direction of the conflict, but reappearing after a certain interval when the				To be assessed in next phase		The Attention Guidance system shall provide a toggle mode (to switch on/off Attention Guidance functionality) in order to not disturb regular controller operations, to

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		separation remained below the set minima, even if the conflict solved)						allow a clear interpretation of the information displayed, and to enable easy interaction for the user.
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•Benefit: ATCO reaction times decrease with the A-R guidance				To be assessed in next phase		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system limited field of view head movements being tiring				To be assessed in next phase		
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system images appearing too brightly on top of the background				To be assessed in next phase		Limitations of use of V/A-R Head-Up display shall be assessed and defined

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 2.3.2: Input devices (e.g. keyboard, mouse, touch screen) correspond to HF principles. [V1: AIR only]		•V/A-R system display coated and not acceptable in many cases, as at night, during bad weather conditions or when studying information (on paper) on the controller working position				To be assessed in next phase		Dark and coated V/A-R Head up display shall not affect real word visibility in good visibility conditions
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		•V/A-R system causes heavy head due to the weight of the head device and not usable during an entire shift				To be assessed in next phase		Weight of the head-up display of V/-A/R head- up display shall be feasible to be worn for an entire shift
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		V/A-R system limited field of view head movements being tiring				To be assessed in next phase		
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		V/A-R system limited field of view not known by ATCO				To be assessed in next phase		A visual indication of the limit of the augmented reality field of view shall be displayed in the V/A-R HMI Head-Up display

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		V/A-R system limited field of view too limited				To be assessed in next phase		The V/AR system shall have at least 30° x 15° minimum field of view for the augmented viewing port.
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		•V/A-R data based on live data not reliable (e.g. data dropouts during final approach)				To be assessed in next phase		Reliability and timeliness of V/A-R displayed data shall be ensured
								The V/AR system shall be fed by primary identification tools (e.g. radar, ADS-B).
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		V/A-R system display coated and not acceptable in many cases, as at night, during bad weather conditions or when studying information (on paper) on the controller working position				To be assessed in next phase		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		V/A-R system images appearing too brightly on top of the background				To be assessed in next phase		V/A-R brightness shall be customisable by end users and saved in a user setting profile
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-6	Benefit :V/A-R Tracking labels increase situation awareness providing flight information in primary tower point of view (out of the window)	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		V/A-R HMI shall provide overlays of airport elements and additional information locally established in the Head-up display during low visibility conditions or when required by end-user
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		V/A-R HMI shall provide tracking labels and additional information locally established in the Head-up display in all visibility conditions

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-7	Benefit :V/A-R Tracking labels display reduces the need of head-down time.	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1014	EXE-05.97.1-TRL4-TVALP-VAR-002	EXE02 - Measured time spent in head-up is increased in the solution scenario with respect to the reference scenario.		V/A-R HMI shall provide overlays of airport elements and additional information locally established in the Head-up display during low visibility conditions or when required by end-user
				CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		V/A-R HMI shall provide tracking labels and additional information locally established in the Head-up display in all visibility conditions
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-27	V/A-R attention guidance alerts are too intrusive and disturb ATCO, generating annoyance with consequent increase in stress level and decrease of job satisfaction and	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - Usability in general was rated just a bit below 50%. The in-your-face warning was considered too intrusive. See also: SESAR 2020 -		Attention guidance alerts The V/AR system shall present attention guidance measures in a non-intrusive

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		acceptance. This issue also affects arguments: Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.				PJ05-W2 Sol 97 TVALP.		and non-repetitive manner.
				CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. And not negatively influenced by the warnings or system in general. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.	Further investigation for shift from LOW VIS to Standard operations including different use cases should be performed	The Attention Guidance shall set different escalation (intensity) levels for the critical events under consideration (e.g. conflicts).
				CRT-05.971-TLR4-TVALP-H105-1020	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - ATCOs rated acceptability of baseline higher and difference between ATCOs was huge. The warnings huge and repeating warning were not really acceptable. Note that the system in general was acceptable! See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - WL was not significant higher for the AR		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				TVALP- H105- 1011		condition compared to the baseline condition. And in both conditions acceptable. No simlog or other (digital) indicators were recorded. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-35	V/A-R attention guidance additional perception cues raised on the augmented reality in case of potentially missed command actions disturbing ATCO that intentionally postponed command actions with consequent increase of workload	OBJ-05.971-TRL4-TVALP-H105-1010	CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - ATCOs did report that the alarms and warnings were too prominent. They needed to put effort into switching them off and were not interested in repeated alarm. As such, for the current version of the system, one can say that the alarms / warnings cause more workload than needed. Note though that no commands or actions were missed. See also: SESAR 2020 -		The Attention Guidance system shall not repeat alerts once it is switched off by end user.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						PJ05-W2 Sol 97 TVALP.		
				CRT- 05.971- TLR4- TVALP- H105- 1013	EXE-05.97.1- TRL4-TVALP- VAR-001	EXE01 - OK - SA was rated as adequate. No reduced SA resulting from alarms / warning's was noticed. Note though that no commands or actions were missed. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		attention guidance alerts The V/AR system shall present attention guidance measures in a non-intrusive and non- repetitive manner.
				CRT- 05.971- TLR4- TVALP- H105- 1011	EXE-05.97.1- TRL4-TVALP- VAR-001	EXE01 - OK - WL was not significant higher for the AR condition compared to the baseline condition. And in both conditions acceptable. No simlog or other (digital) indicators were recorded. Note though that no commands or actions were missed. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - Usability in general was rated just a bit below 50%. This rating had, see also the observations / debriefing, to do with the fact that alarms / warnings do require additional attention. Also because they repeat while ATCOs do not need that repetition. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.	Usability of V/A-R Attention Guidance systems should be improved and further assessed	
				CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 125		
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-19	V/A-R tracking label to present conflict detection alerts are too intrusive and disturb ATCO, generating annoyance with consequent increase in stress level and decrease of job satisfaction and acceptance. This issue also affects	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H105-1020	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01- NOK - ATCOs rated acceptability of baseline higher and difference between ATCOs was huge. Alerts were indeed too intrusive and persistent.	Usability of V/A-R systems should be further assessed	The V/AR system shall present conflicting clearances and runway incursion alerts in a non-intrusive manner (if available) in the

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		arguments: Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.						Head-up display.
								The V/AR system shall allow the customization of the information presented size and the saving in a user setting profile.
				CRT-05.971-TLR4-TVALP-H104-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - ATCOs mentioned several times during the debriefings that they had difficulties using Air Gestures as the system did not always recognise their gestures.		Reliability and timely responsiveness of V/A-R Air Gesture interactions shall be ensured
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-22	V/A-R air gesture interaction is not timely responding and the lack of responsiveness causes ATCO frustration, increase in workload and decrease of ability to accomplish tasks and focus on primary tasks. This issue also affects arguments: Arg. 2.2.2: The	OBJ-05.971-TRL4-TVALP-H104.1010	CRT-05.971-TLR4-TVALP-H104-1017	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 20% of the ATCOs responded that the V/A-R Air Gestures have no impact on the usability whereas the other 80% believes that usability is negatively impacted, mostly from an ergonomic point of view.	Usability of V/A-R Air Gesture systems should be improved and further assessed	
								Reliability and timely responsiveness of V/A-R Air Gesture

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]						interactions shall be ensured
				CRT-05.971-TLR4-TVALP-H104-1011	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 40% of ATCOs' responses is that V/A-R Air Gestures supports ATCO in maintaining workload at acceptable level. Several ATCOs had difficulties using Air Gestures which increased their workload.		
				CRT-05.971-TLR4-TVALP-H104-1014	EXE-05.97.1-TRL4-TVALP-VAR-002	EXE02 - Measured time spent in head-up is increased in the Air Gesture solution scenario with respect to the reference scenario.		
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-23	V/A-R air gesture interaction is recognising wrong gesture and providing a wrong input to the system realised by ATCO causing ATCO decrease in the trust of the system and negatively affecting workload. This issue also affects	OBJ-05.971-TRL4-TVALP-H104.1010	CRT-05.971-TLR4-TVALP-H104-1011	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 40% of ATCOs' responses is that V/A-R Air Gestures supports ATCO in maintaining workload at acceptable level. Several ATCOs had difficulties using Air Gestures which		Reliability and timely responsiveness of V/A-R Air Gesture interactions shall be ensured

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]				increased their workload.		
				CRT-05.971-TLR4-TVALP-H104-1017	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 20% of the ATCOs responded that the V/A-R Air Gestures have no impact on the usability whereas the other 80% believes that usability is negatively impacted, mostly from an ergonomic point of view.	Usability of V/A-R Air Gesture systems should be improved and further assessed	
				CRT-05.971-TLR4-TVALP-H104-1018	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 10% of ATCOs thought the air gestures should be removed and another 20% pointed out that it should be avoided to use air gesture commands for runway authorizations/critical cases.		
				CRT-05.971-TLR4-TVALP-H104-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 80% of ATCOs responded that their trust in the prototype for V/AR Air Gestures is at an acceptable level.		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output t devices, alarm& alerts) is acceptable. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-24	V/A-R air gesture interaction is recognising wrong gesture and providing a wrong input to the system not realised by ATCO causing increase in potential for human error, negatively affecting situation awareness This issue also affects arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	OBJ- 05.971- TRL4- TVALP- H104.1010	CRT- 05.971- TLR4- TVALP- H104- 1015	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - 40% of the ATCOs responses it that the V/A-R Air Gestures increase the potential for human error due to usability issues.		Reliability and timely responsiveness of V/A-R Air Gesture interactions shall be ensured
							Usability of V/A-R Air Gesture systems should be improved and further assessed	
				CRT- 05.971- TLR4- TVALP- H104- 1017	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - Only 20% of the ATCOs responded that the V/A-R Air Gestures have no impact on the usability whereas the other 80% believes that usability is negatively impacted, mostly from an ergonomic point of view.		
				CRT- 05.971- TLR4- TVALP-	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1-	EXE02 - Only 60% of ATCOs responses indicated that V/A-R Air Gestures HMI		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				H104-1013	TRL4-TVALP-VAR-005	supports ATCO in maintaining an adequate level of situation awareness. This was due to the fact that they were not always able to give the clearance with the air gesture.		
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-10	V/A-R Tracking label is attached to wrong aircraft, generating confusion for the ATCO that issue clearance to wrong aircraft with consequent increase in human error, decrease in situation awareness and ability to accomplish tasks. This might negatively affect safety. The issue also affects arguments: Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS.		The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.
				CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO		The V/AR system shall display the tracking labels



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				H103-1013	TRL4-TVALP-VAR-005	in maintaining an adequate level of situation awareness.		and attention guidance alerts with a background colour that do not overshadow the real world view.
				CRT-05.971-TLR4-TVALP-H103-1018	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - At least 75% of the ATCOs confirmed that the system is easy to use (80%), that the interface was clear and complete (80%), that there was not too much inconsistency and that the device is physically comfortable (80%). However, less than 75% of the ATCOs confirmed that they would like to use the system frequently (50%), that they imagine most people can learn to use the system very quickly (70%), that they felt confident using the system (70%), that there		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						was not too much inconsistency (40%) and the device did not cause any negative physical consequences like eyestrain (70%).		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-25	BENEFIT: V/A-R attention guidance increases ATCO situation awareness providing head up alerts that guide the attention to a safety critical event. This benefit might also affects safety.	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01- NOK - Usability in general was rated just a bit below 50%. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.	Usability of V/A-R Attention Guidance systems should be improved and further assessed	
				CRT-05.971-TLR4-TVALP-H105-1014	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - Head up time was not measured in seconds. Subjectively the ATCOs were convinced that the system offered them the opportunity to spent more head-up time. This was reported to be positive for SA, as well as the call signs projected next to the A/C. See also: SESAR 2020 -		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						PJ05-W2 Sol 97 TVALP.		
				CRT- 05.971- TLR4- TVALP- H105- 1013	EXE-05.97.1- TRL4-TVALP- VAR-001	EXE01- OK - SA was rated as adequate. In AR condition slightly higher (not significant) compared to the baseline. See also the comment above about relevance of call signs for SAS See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-26	V/A-R attention guidance lack of responsiveness reduces ATCO situation awareness alerting late about safety critical events, with possible increase of human error. This might affect safety. This issue also affects arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 2.2.2: The	OBJ- 05.971- TRL4- TVALP- H105.1010	CRT- 05.971- TLR4- TVALP- H105- 1018	EXE-05.97.1- TRL4-TVALP- VAR-001	EXE01- NOK - Usability in general was rated just a bit below 50%. Safety critical events were spotted fast, and AR in itself was perceived as helpful, a confirmation where ATCOs needed to focus upon. But in particular for these critical events they experienced no problems identifying the situation without guidance as well.	Usability of V/A-R Attention Guidance systems should be improved and further assessed	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		timeliness of information provided by the system is adequate for carrying out the task.				See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01- OK - SA was rated as adequate. In AR condition slightly higher (not significant) compared to the baseline. No concern about reduced SA was explicitly mentioned. SA is better maintained, in particular due to the A/Labels. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1019	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. In AR condition slightly higher (not significant) compared to the baseline. No concern about reduced SA was explicitly mentioned. The warnings can be seen as a kind of		Limitations of use of V/A-R Head-Up display shall be assessed and defined

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						safety net to never miss a warning. Th warnings for taxiway conflicts are a bit "artificial". See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - Possibly the fact that the HoloLens is a bit dark (like sunglasses) might reduce the ability to quickly view head down information... See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		Dark and coated V/A-R Head up display shall not affect real word visibility in good visibility conditions
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-11	V/A-R Tracking label overshadows the OTW view and ATCO that cannot see other vehicles or aircraft in the movement area due to the TL covering the ATCO's line of sight, negatively affecting situation awareness, human error and ability to accomplish tasks. This may negatively affect safety. The issue also affects	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations.		The V/AR system shall display a visual indication of the limit of the augmented reality field of view in the Head-up display.
				CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-	EXE02 - Only 50% of the ATCOs agreed that the tracking label and the airport overlay		The Attention Guidance system shall display the visual elements

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		arguments: Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]		H103-1015	TRL4-TVALP-VAR-005	provided by V/A-R were adequate and did not generate confusion neither disturbance. ATCOs commented that the labels were overlapping and covering the background and that they were sometimes badly aligned. 80% of the ATCOs agreed that they always had an adequate field of view when using the V/A-R system to perform their task.		in a way that do not overshadow the final approach path and initial climbing path.
				CRT-05.971-TLR4-TVALP-H103-1018	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - At least 75% of the ATCOs confirmed that the system is easy to use (80%), that the interface was clear and complete (80%), that there was not too much inconsistency and that the device is physically comfortable (80%). However, less than 75% of the ATCOs		The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						confirmed that they would like to use the system frequently (50%), that they imagine most people can learn to use the system very quickly (70%), that they felt confident using the system (70%), that there was not too much inconsistency (40%) and the device did not cause any negative physical consequences like eyestrain (70%).		
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		Tracking labels displayed in the Head-Up HMI shall not overlap between each others
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-1	V/A-R Tracking label provides too many information and ATCO is disturbed and annoyed, negatively affecting situation awareness. This might negatively affect ATCO Productivity.	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.	Number of Information provided in the Head-Up HMI of V/A-R display should be predefined according to	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		This issue also affects arguments: Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.					an initial minimum set and customisable by end-user in a user-setting profile	
				CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		The V/AR system shall display information in the Head-up HMI based on actual data.
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-2	V/A-R airport layers not aligned to airport layout decreases situation awareness in low visibility conditions. This issue might also affect safety This issue also affects argument: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information. Only 50% of the ATCOs agreed that the tracking label		The V/AR system shall display the airport layers in the Head-up HMI aligned with real world elements (e.g. RUNWAY, TAXIWAY, etc.).
				CRT-05.971-	EXE-05.97.1-TRL4-TVALP-			The V/AR system shall

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.		TLR4-TVALP-H103-1015	VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	and the airport overlay provided by V/A-R were adequate and did not generate confusion neither disturbance. ATCOs commented that the labels were overlapping and covering the background and that they were sometimes badly aligned. 80% of the ATCOs agreed that they always had an adequate field of view when using the V/A-R system to perform their task. 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness. The prototype for V/AR contributes to Cost Efficiency performance by having a positive impact on situation		display a visual indication of the limit of the augmented reality field of view in the Head-up display.
								The V/AR system shall display the tracking labels in a way that do not overshadow final approach path and initial climbing path.
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005			The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						awareness, workload and efficiency of ground operations, especially in low visibility conditions. ATCOs' situation awareness and workload with the implementation of Virtual/Augmented Reality applications is maintained at acceptable level and therefore not reducing safety levels.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-3	Benefit: V/A-R additional information increase situation awareness in low visibility conditions and in good visibility conditions providing relevant data in the head-up tool. This benefit also affects Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		V/A-R HMI shall provide overlays of airport elements, tracking labels and additional information locally established in the Head-up display during low visibility conditions or when required by end-user

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		sufficient level of situation awareness. Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.						The V/AR system shall depict conformal information as overlapped to the real object it is associated to.
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		V/A-R HMI shall provide tracking labels and additional information locally established in the Head-up display in all visibility conditions
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-4	V/A-R additional information not adequate negatively affects situation awareness by providing not updated data and/or not relevant data and/or too many data in the head-up tool. This issue also affects: Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		The V/AR system shall display information in the Head-up HMI based on actual data.
								The tracking label shall be updated taking into account the new aircraft status.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
								<p>a) Once the aircraft has landed and is on ground, the label changes to the ground mode.</p> <p>b) Once the aircraft is airborne, the label changes to the airborne mode.</p> <p>c) Description on clearance displayed.</p>
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-5	Benefit: V/A-R airport layers increase situation awareness in low visibility conditions providing overlayer to out of the window view. This benefit also affects argument: Arg. 2.3.3: Visual	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on		V/A-R HMI shall provide overlays of airport elements and additional information locally established in the Head-up

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		displays and other types of output devices adhere to HF principles. [V1: AIR only] Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.				the quality of the information.		display during low visibility conditions or when required by end-user
								V/A-R HMI shall provide tracking labels and additional information locally established in the Head-up display in all visibility conditions
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-13	V/A-R Tracking label does not provide adequate and timely safety net advisory and ATCO is confused/misled/annoyed by alerts, negatively affecting situation awareness, human error, ability to accomplish tasks and	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1019	EXE-05.97.1-TRL4-TVALP-VAR-002	EXE02 - All ATCOs responses indicated that alerts in the prototype for V/AR are effective and not intrusive and 90% of the responses indicated that the alerts support ATCOs in the early detection of ATC		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		focus on primary tasks. This might negatively affect safety. This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]				critical situations with respect to conflicting clearances and runway incursions.		
				CRT-05.971-TLR4-TVALP-H103-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS. The prototype for V/AR with safety nets improved the perceived safety performance by reducing potential for human error.	V/A-R Head-up display may provide alerts for runway incursion	The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.
				CRT-05.971-	EXE-05.97.1-TRL4-TVALP-	EXE02 - 90% of ATCOs' responses		The V/AR system shall

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				TLR4- TVALP- H103- 1013	VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-16	V/A-R tracking label distinguish code indicates lining-up aircraft for arrival flight generating ATCO's decrease of situation awareness and potential increase of human error. This issue also affects argument: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	OBJ- 05.971- TRL4- TVALP- H103.1010	CRT- 05.971- TLR4- TVALP- H103- 1016	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A- R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS.		Reliability and timeliness of V/A-R displayed data shall be ensured
				CRT- 05.971- TLR4-	EXE-05.97.1- TRL4-TVALP- VAR-002	EXE02 - 80% of ATCOs' responses indicated an		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				TVALP- H103- 1020	EXE-05.97.1- TRL4-TVALP- VAR-005	adequate level of acceptance of the V/A-R tool.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-17	V/A-R tracking label fails to present conflict detection alerts generating ATCO decrease of situation awareness and possible increase of human error. This might affect safety. This issue also affects arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	OBJ- 05.971- TRL4- TVALP- H103.1010	CRT- 05.971- TLR4- TVALP- H103- 1012	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on the quality of the information.		Reliability and timeliness of conflicting clearances and runway incursions alerts shall be ensured if available in the HMI V/A-R head up display
				CRT- 05.971- TLR4- TVALP- H103- 1019	EXE-05.97.1- TRL4-TVALP- VAR-002	EXE02 - All ATCOs responses indicated that alerts in the prototype for V/AR are effective and not intrusive and 90% of the responses indicated that the alerts support ATCOs in the early detection of ATC critical situations with respect to conflicting clearances and runway incursions.		
				CRT- 05.971- TLR4- TVALP-	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1-	EXE02 - Only 60% of the ATCOs agreed that the V/A- R system did not		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				H103-1016	TRL4-TVALP-VAR-005	increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS.		
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-18	V/A-R tracking label (to present conflict detection alerts) lack of responsiveness reduces ATCO situation awareness alerting late about safety critical events, with possible increase of human error.	OBJ-05.971-TRL4-TVALP-H103.1010	CRT-05.971-TLR4-TVALP-H103-1012	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs provided positive feedback on quantity of information provided by V/A-R. However, only 50% of the ATCOs provided positive feedback on		Reliability and timeliness of conflicting clearances and runway incursions alerts shall be ensured if available in the

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
		This might affect safety. This issue also affects arguments: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.				the quality of the information.		HMI V/A-R head up display
				CRT-05.971-TLR4-TVALP-H103-1013	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - 90% of ATCOs' responses indicated that V/A-R HMI supports ATCO in maintaining an adequate level of situation awareness.		
				CRT-05.971-TLR4-TVALP-H103-1016	EXE-05.97.1-TRL4-TVALP-VAR-002 EXE-05.97.1-TRL4-TVALP-VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A-R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS. The prototype for V/AR with safety nets improved the perceived safety performance by		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						reducing potential for human error.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-28	V/A-R attention guidance fails to identify a safety critical event generating ATCO decrease of situation awareness and possible increase of human error. This might affect safety. This issue also affects arguments: Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1016	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - HERSA was not applied. Though no reason for increased likelihood of human error was raised during the debriefings. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		Reliability and timely responsiveness of V/A-R attention Guidance alerts shall be ensured
				CRT-05.971-TLR4-TVALP-H105-1019	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. No link with human error was made during the debrief / discussions. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - Usability in general was rated just a bit below 50%. The event that no guidance would be given was not considered a realistic problem. ATCOs do / should know See also:		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-31	V/A-R attention guidance visual cues guiding the ATCO's gaze on a safety critical event fails to track ATCO's attention and provides wrong information about where the attention is needed causing a decrease of situation awareness. This might also affects safety. This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - The message was always (in debriefings and during the experiments) clear and always attracted the ATCOS' attention, no confusion was identified. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate on SASHA. ATCOs said that SA was enhanced in particular due to call signs on labels next to every A/C. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.8: The user interface supports a	W2.PJ05.97-HP-V/A-R-32	V/A-R attention guidance visual cues not recognized by ATCO due to head	OBJ-05.971-TRL4-TVALP-	CRT-05.971-TLR4-TVALP-	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - ATCOs were positive and did not complain about the information density		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
sufficient level of individual situation awareness. [V1: AIR only]		mounted display overcrowded of information with consequent decrease of ATCO situation awareness and increase in human error. This might also affects safety. This issue also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	H105.1010	H105-1012		on the display. The only thing, as earlier said was that the warnings were too intrusive and persistent. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 114		
				CRT-05.971-TLR4-TVALP-H105-1011	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - WL was not significant higher for the AR condition compared to the baseline condition. And in both conditions acceptable. No simlog or other (digital) indicators were recorded. The AR setup did result in one additional WL however. ATCOs considered this to be the result of the new system and not a structural effect caused by AR. See		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1012	EXE-05.97.1-TRL4-TVALP-VAR-001	See line 115		
				CRT-05.971-TLR4-TVALP-H105-1016	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - HErSA was not applied. Though no reason for increased likelihood of human error was raised in the questionnaires or during the debriefings. The researchers think that there was no serious display clutter and therefore the display was not "overcrowded". It might contribute to less HE if it turns out that ATCOs are guided better to the event that requires their attention. However, that was not proven in the current study. See also: SESAR 2020 -		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1018	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - NOK - Usability in general was rated just a bit below 50%. As stated earlier that has to do with the first design phase however, display clutter was not mentioned as one of the usability issues that needs to be worked on. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-33	V/A-R attention guidance information overcrowding ATCO line of sight, negatively affecting ATCO situation awareness	OBJ-05.971-TRL4-TVALP-H105.1010	CRT-05.971-TLR4-TVALP-H105-1013	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. In AR condition slightly higher (not significant) compared to the baseline. However, ATCOs did say that warnings attracted too much of their attention. As such subjectively speaking the AR warnings are indeed asking too much for		The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						ATCO attention and as such possibly influence SA in a negative way. Note that the same system (AR) can bot have a negative as well as a positive effect on SA, and that both effects should actually be compared. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
				CRT-05.971-TLR4-TVALP-H105-1015	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - Only 50% of the ATCOs agreed that the tracking label and the airport overlay provided by V/A-R were adequate and did not generate confusion neither disturbance. ATCOs commented that the labels were overlapping and covering the background and that they were sometimes badly aligned. 80% of the ATCOs agreed that		The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
						they always had an adequate field of view when using the V/A-R system to perform their task.		
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]	W2.PJ05.97-HP-V/A-R-34	V/A-R Attention Guidance different views between team members does not provide the same level of information and ATC team communication (TWR RWY/TWR GND) are negatively affected, negatively affecting team situation awareness, human error. This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 3.3.5: Team members can maintain a sufficient level of shared situation awareness.	OBJ-05.971-TRL4-TVALP-H105-1010	CRT-05.971-TLR4-TVALP-H105-1021	EXE-05.97.1-TRL4-TVALP-VAR-001	EXE01 - OK - SA was rated as adequate. In AR condition slightly higher (not significant) compared to the baseline. Further the tool on the one hand offers the opportunity to share information if all ATCOs are wearing the HoloLens. However, it can be that one ATCOs uses it and another one doesn't. In that case sSA might be hindered. This variable was not included in the current study. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.	In case of usage of V/A-R display for one member of the team, it should be assessed if there is any impact on the overall team	Tracking labels displayed in the Head-Up HMI shall not overlap between each others
				CRT-05.971-TLR4-	EXE-05.97.1-TRL4-TVALP-VAR-001	HERSA was not applied. No remarks about likelihood of		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteri a ID	EXE/Activit y	Evidence Description	REC	REQ
				TVALP- H105- 1016		human error resulting from possibly reduced sSA were made by the ATCOs. See also: SESAR 2020 - PJ05-W2 Sol 97 TVALP.		
Arg. 2.3.9: The user Interface design supports a sufficient level of team situational awareness. [V1: AIR only]	W2.PJ05.97- HP-V/A-R-14	V/A-R Tracking label different views between team members does not provide the same level of information and ATC team communication (TWR RWY/TWR GND) are negatively affected, negatively affecting team situational awareness, human error. This issue also affects arguments: Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only] Arg. 3.3.5: Team members can maintain a sufficient level of shared situational awareness.	OBJ- 05.971- TRL4- TVALP- H103.1010	CRT- 05.971- TLR4- TVALP- H103- 1020	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - 80% of ATCOs' responses indicated an adequate level of acceptance of the V/A-R tool.		Tracking labels displayed in the Head-Up HMI shall not overlap between each others
				CRT- 05.971- TLR4- TVALP- H103- 1021	EXE-05.97.1- TRL4-TVALP- VAR-002	EXE02 - All ATCOs agreed that the V/A- R HMI supports ATCO team in maintaining a sufficient level of situational awareness.	V/A-R Head- up display may provide alerts for conflicting aircraft	
				CRT- 05.971- TLR4- TVALP- H103- 1016	EXE-05.97.1- TRL4-TVALP- VAR-002 EXE-05.97.1- TRL4-TVALP- VAR-005	EXE02 - Only 60% of the ATCOs agreed that the V/A- R system did not increase potential for human error compared to current operations. The current V/A-R interface design could lead to a potential for Human		



<i>ARG.</i>	<i>IS/BEN_ID</i>	<i>Issue/BEN</i>	<i>HP Val obj ID</i>	<i>Suc criteri a ID</i>	<i>EXE/Activit y</i>	<i>Evidence Description</i>	<i>REC</i>	<i>REQ</i>
						Error because the labels sometimes cover part of the manoeuvring area and the controller may not see an obstacle that is not detected by radar or GPS.		

Table 22: Summary of the V/A-R HP results and recommendations/ requirements for each identified issue & related argument

9.2 Maturity of the Solution

This section contains the HP maturity review at the end of the validation activity to give advice on the transition to the next TRL6-phase.

Maturity checklist for finalising the V2/TRL4 assessment

ID	Question	Answer <i>Fill in 'yes' or 'no'.</i>	Comments <i>Please substantiate your answer.</i>
1	Have relevant arguments for V2/TRL4 been addressed and appropriately supported?	Yes	See Section 5.6.1
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 V2/TRL4)?	Yes	See Section 5.6.1
3	Have potential interactions with related projects/concepts started to be considered?	Yes	No related SESAR solutions have been identified to be considered in the HP assessment for solution PJ05-97.1
4	In case of different options of the proposed solution, is the decision for a specific option(s) based on the consideration of HP benefits and issues?	Yes	No different options proposed by the projects. There might be local implementation needs (e.g. type of alerts to be displayed in the Head-up, colour coding etc.).
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	See TVALR
6	Are the assessment 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	See Section 5.6.1
7	Has the proposed solution been tested with end-users and started to be tested under sufficiently realistic conditions, including certain abnormal and degraded conditions?	Yes	See section 5.5.1



8	Are the outcomes based on the solution assessment mature enough to start V3/TRL6?	Yes	See TVALR
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSD, SPR)?	Yes	HPAR, SAR and TS/IRS have been updated after the collection of the project output
10	Have the major factors that can influence the transition feasibility (e.g. changes in automation level, changes in staff requirements, such as competence, staffing levels) been considered? Are there any ideas on how to overcome any such issues?	Yes	See Section 5.6.1
11	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	See section 4.1.6
12	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	See Section 5.6.1

10 Step 4 Collate findings & conclude on transition to TRL6-phase PJ.05-W2-97.2

10.1 Summary of HP activities results & recommendations / requirements

The following table provides the Summary of HP activities results & recommendations / requirements for solution PJ.05-W2-97.2.

Even if some of the validation exercises results are not directly mentioned in the table, all the validation activities have been taken into account for the requirements and recommendations definition as all the validation exercises report was used to prepare the post simulation workshops and they were represented to provide subjective feedback at the final and post simulation workshop.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.	W2.PJ05.97-HP-ASR-36	Operating methods with the introduction of ASR are not clearly identified for normal, abnormal and degraded mode conditions, negatively affecting trust in the new technology	OBJ-05.972-TRL4-TVALP-H106.2020	CRT-05.972-TLR4-TVALP-H106-2021	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	N/A <u>EXE 007</u> All ATCO (100%) responded that the operating method working with ASR was clear and consistent. Majority of ATCOs qualitative		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						feedback report that they were satisfied about the tool's latency and feedback provided which allowed them to apply operating methods in an accurate, efficient, and timely manner. All ATCOs agreed that they experienced no change in operating methods.		
Arg. 1.2.1: Operating methods cover operations in normal operating conditions.		ISSUE/BENEFIT: Demand and fatigue might be reduced due to ATCO manual interaction reduction, but might also increase due to ATCO being less involved and performing more monitoring than acting.				To be assessed in next phase	Demand and fatigue should be further assessed in case of ASR use	
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.	W2.PJ05.97-HP-ASR-44	ASR system and functions affecting existing CWP systems and tools (e.g. EFPS etc.) causing ATCO decrease in situation awareness and ability	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2016	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-	Indra-HC exercise (004): In contrary to what the HP issue says, ATCOs welcomed the callsign highlight	ASR system further enhancement may be developed to support AIR-GND	#

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		to accomplish tasks. This issue also affects arguments: Arg. 1.3.2: Tasks can be achieved in a timely manner. Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.			TRL4-TVALP-ASR-007	functionality, which helped to visually emphasize the strip related to the aircraft in the EFS bay. This was regarded as a potential situational awareness enhancing functionality. However, the ASR system was not at such level of maturity to gather very positive feedback in its current state. As an alternative use for voice recognition, it came up that instead of automatically updating the EFS, the system could be used to check whether the pilot provided the correct readback and notify the ATCO in case of a	communications for callsign highlight and clearance readback conformance monitoring	
								#
								The HMI shall present the recognized command types together with the command values in the Electronic Flight Strip or in a dedicated place on the HMI.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>mismatch. Such an “error prevention” functionality could have a positive impact on safety and overall end-user acceptance. EXE 006: In the past, ATCOs used to push a flight strip to the left or to the right to make the work assignments more easier to spot. In this way, they separated the AC according to the degree of processing. Now the same could be achieved electronically. E.g. To push the left/right those strips that are a step towards transfer to another sector etc.</p> <p><u>EXE 007</u></p> <p>ATCOs (100%)</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>provided positive feedback on usability of the ASR system.</p> <p>Overall, ATCOs were confident about using ASR and would like to use it frequently. They found ASR easy to use and its functions well integrated. Half the ATCOs agreed that they would need initial support in order to be able of effectively using the system, and most of them agreed that some training on the system would be required, to understand how the tool “behaves” and also to learn how to proactively adapt their speech to ASR. Generally, the system wasn’t</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						found complex, and no inconsistencies were reported. Some concerns due to unfamiliarity in using the pedal to activate the ASR, also were reported.		
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.		ASR Can also increase head-down time to check whether the system is registering and executing the right input (versus one-click input in reference situation). o ASR system provides a benefit mostly to a strip-environment and less to a stripless environment. Mainly it will depend on the integration. To achieve the workload benefits and the head-up benefits the integration of the system shall be complete and well performed (the ASR main benefit would be						The HMI shall enable acceptance of automatically inserted value by ATCO clicking on the value, by enabling automatic acceptance of recognized command values if the controller does not correct them within a predefined time frame (e.g. 10 seconds). Automatic acceptance is preferable according to HP results

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		highlighting the callsign from pilot utterance, in EFS environment, the ASR input would have to be integrated into the electronic flight strip)						
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.	W2.PJ05.97-HP-ASR-37	ASR failure to identify an aircraft and no aircraft is highlighted, decreasing ATCO situation awareness and ATCO productivity (timely task execution) while ATCO is waiting for callsign highlight that does not happen: Consequent decrease of ATCO trust (frustration) /acceptance of ASR tool Lack of operating methods This issue also affects argument: Arg. 1.2.3: Operating methods cover degraded modes of the ATM system. Arg. 1.3.4: The level of trust in the new concept/the new	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2012	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	In the Indra-HC exercise (004), the system was not operationally reliable to measure situational awareness. EXE 006:Delays in displayed feedback can slow down important decisions in a planned AC separation or any other aspect of the ATC decision. EXE 007 100% of ATCOs responded that ASR supports ATCO in maintaining an adequate level of	ASR should give a response not later than 1.0 second after the controller has pressed the push-to-talk-button, by sending the recognized callsign to the cooperating ATC system. Remark: If the	Delay between the voice communication and the displayed feedback shall be reduced to the possible minimum and shall be subject to ATCOs 'acceptability'. Initial acceptable assessed value is 1s

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		<p>procedures is appropriate.</p> <p>Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.</p> <p>Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.</p> <p>Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.</p>				<p>situation awareness.</p> <p>Moreover, it was indicated that when using the system, ATCOs feel like they are provided with increased required information, compared with the amount they have normally available and which they should look for on their own; as a result they were able to better plan their work. The 'Hook' function was reported to help improving situational awareness. All ATCOs rated situational awareness as either 'high' or 'perfect' during solution scenarios, which suggests that controllers were generally</p>	<p>callsign is not recognized after the callsign is said, ASR MAY send recognized callsign together with the whole recognized command even if it is recognized during the utterance (e.g. if ASR needs the other contextual information to recognize the callsign properly or the controller gives the callsign information at the end of the utterance). If a command is not started with a callsign,</p>	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>satisfied about their situational awareness levels when using ASR.</p> <p>Some improvements were also identified - see the recommendations associated.</p>	<p>the callsign information may be sent first followed by the rest of the recognized command. If an utterance contains more than one callsign (break, break), only the first callsign may be sent first.</p>	
							<p>For 99.9% of the ATCO utterances except callsign itself, the system should be able to give the final speech-to-text and text-to-concept result latest one second after the ATCO has released the</p>	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
							push-to-talk button.	
							The ASR shall start with the recognition of the spoken language directly after the first word has been spoken.	
				CRT-05.972-TLR4-TVALP-H106-2016	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	In the Indra-HC exercise (004), 66.7% of the ATCOs gave a positive feedback in the questionnaire about the callsign recognition capability of the system. Based on the responses, the system's performance was at its strongest when it had to understood the callsigns and when it did, the callsign highlight automatically happened. This	ASR recognition system should be integrated in current CWP in order to use the local GND-AIR microphone as source of voice to achieve a good level of fidelity	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>functionality was highly welcomed. Furthermore, they suggested to use headset instead of microphone to increase fidelity. It seemed that the system recognized the instructions more robustly with the headset.</p> <p>EXE 007 ATCOs (100%) provided positive feedback on usability of the ASR system.</p> <p>Overall, ATCOs were confident about using ASR and would like to use it frequently. They found ASR easy to use and its functions well integrated. Half the ATCOs agreed that they would need initial support in order to</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>be able of effectively using the system, and most of them agreed that some training on the system would be required, to understand how the tool "behaves" and also to learn how to proactively adapt their speech to ASR. Generally, the system wasn't found complex, and no inconsistencies were reported.</p> <p>Some concerns due to unfamiliarity in using the pedal to activate the ASR, were reported.</p>		
				CRT-05.972-TLR4-TVALP-H106-2011	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006	<p>Not applicable as workload could not be measured during the tests</p> <p>EXE 007</p>		





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
					EXE-05.97.2-TRL4-TVALP-ASR-007	<p>Feedback from controllers (100%) shows that ASR supports controllers in maintaining an acceptable level of workload.</p> <p>The average level of workload reported for the solution scenarios (3.5 out of 10) was below the maximum tolerable WL level (5) and identical to the average workload level calculated for the reference scenario. Moreover, all ATCOs agreed that the level of workload during the solution scenarios was acceptable and the 'hook' function was reported as the main</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						contributor to this judgment		
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.		•BENEFIT: The automatic highlight and clearance recognition might reduce the potential for human error for the clearance input and the flight selection			To be assessed in next phase			#
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.		•BENEFIT: Usability might be improved improving user experience			To be assessed in next phase			#
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-ASR-38	BENEFIT: ASR reduces workload suggesting ATCO command based on ATCO-Flight R/T. This might also affect ATCO productivity productivity and reduce head down time	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2011	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Not applicable as workload could not be measured during the tests <u>EXE 006</u> : Job training would be much easier for inexperienced controllers (to understand new ATC to stick to phraseology) or for those ATCs who haven't been in ops for a while. The ASR display mode is		#



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>transparent and easily visible and errors are easily detected. Could replace simulation pilots. Also good help for the supervisors - good info for sups.</p> <p><u>EXE 007</u></p> <p>Feedback from controllers (100%) shows that ASR supports controllers in maintaining an acceptable level of workload.</p> <p>The average level of workload reported for the solution scenarios (3.5 out of 10) was below the maximum tolerable WL level (5) and identical to the average workload level calculated for the reference</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						scenario. Moreover, all ATCOs agreed that the level of workload during the solution scenarios was acceptable and the 'hook' function was reported as the main contributor to this judgment		
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-ASR-42	ASR recognised command HMI integration in the CWP does not adhere to HF principles generating increasing in ATCO workload and decrease in situation awareness. This issue might also affects argument: Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]	OBJ-05.972-TRL4-TVALP-H106-2010	CRT-05.972-TLR4-TVALP-H106-2011	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise (004): Whilst workload measurement was not possible due to the characteristics of the validation being rather technical, with regards to the issue mentioned, four out of six ATCOs liked the way commands appeared on the HMI. The only drawback was the one explained above (i.e. as it is not the end-user		#
								95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>but the system that updates the EFS and moves them across the bays, SA may be reduced. In case there is an error in the pilot readback, this can be problematic as it could lead to confusion.)</p> <p><u>EXE 006</u>: Job training would be much easier for inexperienced controllers (to understand new ATC to stick to phraseology) or for those ATCs who haven't been in ops for a while. The ASR display mode is transparent and easily visible and errors are easily detected. Could replace simulation pilots. Also good help for the supervisors - good info for sups.</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p><u>EXE 007</u></p> <p>Feedback from controllers (100%) shows that ASR supports controllers in maintaining an acceptable level of workload.</p> <p>The average level of workload reported for the solution scenarios (3.5 out of 10) was below the maximum tolerable WL level (5) and identical to the average workload level calculated for the reference scenario.</p> <p>Moreover, all ATCOs agreed that the level of workload during the solution scenarios was acceptable and the 'hook' function</p>		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						was reported as the main contributor to this judgment		
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.		If the ATCO would have to accept/reject the clearance recognition, workload will not be reduced compared to the reference and waiting time will be introduced/increased.						The HMI shall enable acceptance of automatically inserted value by ATCO clicking on the value by enabling automatic acceptance of recognized command values if the controller does not correct them within a predefined time frame (e.g. 10 seconds)
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	W2.PJ05.97-HP-ASR-45	Due to the late (delayed) ASR recognition and highlight of aircraft callsign the ATCO is unable to complete his/her task efficiently (recognition rate, time wait for the recognition output): Consequent ATCO decrease in ASR tool trust/acceptance This issue also affects argument: Arg. 1.3.3: The level of	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2016	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise (004): Callsign highlight was highly regarded, which could support situational awareness. However, there were a number of issues that have to be corrected or further improved, e.g. the size of the vocabulary and the system latency to		95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		workload (induced by cognitive and/or physical task demands) is acceptable. Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate. Arg. 2.1.2: Changes to the task allocation between human and machine support human performance. Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task. Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.				<p>recognise a variety of commands.</p> <p><u>EXE 007</u></p> <p>ATCOs (100%) provided positive feedback on usability of the ASR system.</p> <p>Overall, ATCOs were confident about using ASR and would like to use it frequently. They found ASR easy to use and its functions well integrated. Half the ATCOs agreed that they would need initial support in order to be able of effectively using the system, and most of them agreed that some training on the system would be required, to understand how</p>		latency shall be further assessed and defined #

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>the tool “behaves” and also to learn how to proactively adapt their speech to ASR. Generally, the system wasn’t found complex, and no inconsistencies were reported.</p> <p>Some concerns due to unfamiliarity in using the pedal to activate the ASR, also were reported.</p>		
Arg. 2.1.6: The level of trust in automated functions is appropriate.	W2.PJ05.97-HP-ASR-43	ASR command predictor forecasts possible future ATCO's command that is not relevant for the ATCO communication to pilot and proposes an ATC concept based on the utterance which is not relevant for the communicated clearance, annoying ATCO that realizes the suggestion is not valid with a potential	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2017	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	<p>N/A</p> <p>EXE 006: Disparities amongst ATCOs in Europe regarding familiarity with automated tools - unified training at European level needs to be developed</p> <p><u>EXE 007</u></p> <p>ATCOs provided</p>		95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		decrease of trust in the system. This issue might also affects argument: Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.				positive feedback on acceptance of the ASR tool in 94% of cases. Moreover, 100% of ATCOs judged acceptable the frequency of wrong highlighted callsign and frequency of wrong recognised ASR commands, as well as the tool's latency, considering the traffic scenario under evaluation		
				CRT-05.972-TLR4-TVALP-H106-2015	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	N/A EXE 006: Disparities amongst ATCOs in Europe regarding familiarity with automated tools - unified training at European level needs to be developed <u>EXE 007</u> ATCOs (100%) provided positive		#



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>qualitative feedback on callsign and command recognition rate. Four out of six ATCOs (nearly 70%) reported that the callsign rejection rate and command rejection rate were acceptable</p> <p>During the debriefings, controllers mentioned they were happy with the ASR recognition rate and that it contributes to the high trust in the ASR system.</p>		
				CRT-05.972-TLR4-TVALP-H106-2018	<p>EXE-05.97.2-TRL4-TVALP-ASR-004</p> <p>EXE-05.97.2-TRL4-TVALP-ASR-006</p> <p>EXE-05.97.2-TRL4-TVALP-ASR-007</p>	<p>N/A</p> <p>EXE 006: Disparities amongst ATCOs in Europe regarding familiarity with automated tools - unified training at European level</p>		





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>needs to be developed</p> <p>EXE 007</p> <p>Five out of six ATCOs (nearly 83%) provided positive feedback on trust of the ASR tool.</p> <p>During the debriefings, controllers mentioned they were happy with the ASR recognition rate and that it contributes to the high trust in the ASR system.</p>		
Arg. 2.1.6: The level of trust in automated functions is appropriate.		•BENEFIT: Level of trust might be improved if the system has a high recognition rate			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•The performance of ASR support might increase ATCO stress, frustration and decrease situation awareness, with consequent workload increase, in case the performance of the technical system are not as expected in terms of recognition rate (low recognition rate), time wait for the recognition output			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•Potential for overreliance on ASR support			To be assessed in next phase			Local procedures and training shall be put in place to maintain ATCOs skill in working without ASR support to avoid ASR overreliance
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•ATCOs continuously need to check the system and thus no improvement in terms of workload reduction can be achieved			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•ATCOs not realising if the pilot readback is not aligned with the given clearance			To be assessed in next phase		ASR system further enhancement may be developed to support AIR-GND communications for callsign highlight and clearance readback conformance monitoring	
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•Latency of ASR not adequate causing ATCOs disturbance			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•ASR using microphone and not robustly recognizing ATCOs instructions			To be assessed in next phase		ASR recognition system should be integrated in current CWP in order to use the local GND-AIR microphone as source of voice to achieve a good level of fidelity	





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•ASR engine missing accents or female/male voice training providing worse performance			To be assessed in next phase		The ASR recognition system engine should be based on real OPS communication data	
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•ASR output speed not adequate for the ATCOs			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
Arg. 2.2.1: The accuracy and timeliness of information provided by the system is adequate for carrying out the task.		•In case of non-recognition, double effort to manually recognize the error and correct it compared to pen input			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
Arg. 2.3.3: Visual displays and other types of output devices adhere to HF principles. [V1: AIR only]		•Checking ASR output in the flight strip display might slow some ATCOs, because without ASR ATCOs tick while speaking .			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
								latency shall be further assessed and defined
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	W2.PJ05.97-HP-ASR-40	Wrong highlighted ASR callsign is not realised by ATCO with potential of Human Error increase: ATCO does not realize that the wrong callsign is highlighted and issues clearance to the wrong highlighted flight Consequent decrease of situation awareness due to wrong highlighted callsign Potential of overreliance on the ASR tool support This issue also affects argument: Arg. 1.2.3: Operating methods cover degraded modes of the ATM system. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.3: The level of workload (induced by cognitive and/or	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2013	EXE-05.97.2-TRL4-TVALP-ASR-004	Indra-HC exercise (004): Although human error could not be explicitly measured, the feedback received with regards to situational awareness applies here as well. ATCOs expressed their concerns that they may not realise if the pilot readback is not aligned with the given clearance. In the Indra exercise (004), the system sometimes mixed up the callsigns (e.g. WZZ vs WIF), and if a matching callsign was found by mistake, it was automatically highlighted. This issue could be even more pronounced in an environment		95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
					EXE-05.97.2-TRL4-TVALP-ASR-006			ASR HMI shall not highlight any callsign in case of uncertainty in callsign recognition is above a percentage to be defined locally.
					EXE-05.97.2-TRL4-TVALP-ASR-007			ASR HMI shall highlight the recognised callsign in a different colour in case of uncertainty in callsign recognition in a range of percentage to be assessed.

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		physical task demands) is acceptable.				<p>where the callsigns are similar (e.g. a lot of WIFs in Norway airports).</p> <p>EXE 007</p> <p>Four out of six ATCOs (nearly 70%) responded that the ASR does not increase the potential for human error compared to current operations.</p> <p>During the debriefings, ATCOs provided positive general feedback for the ASR system, and no negative comments were given when asked about the system's potential to increase human error.</p>		
				CRT-05.972-	EXE-05.97.2-TRL4-TVALP-	Indra-HC exercise (004): POK, as the		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
				TLR4-TVALP-H106-2015	ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	<p>subjective perception of callsign recognition, clearance recognition and understanding other parameters were below the cut-off line (at least 75%). However, the speed and accuracy of the callsign recognition was highly regarded.</p> <p><u>EXE 007</u></p> <p>_ATCOs (100%) provided positive qualitative feedback on callsign and command recognition rate. Four out of six ATCOs (nearly 70%) reported that the callsign rejection rate and command rejection rate were</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						acceptable During the debriefings, controllers mentioned they were happy with the ASR recognition rate and that it contributes to the high trust in the ASR system.		
				CRT-05.972-TLR4-TVALP-H106-2016	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise (004): The usability in terms of ASR performance was not optimal, and the HMI related questions did not meet the cut-off score criteria either as the ASR HMI was not designed for an operational validation. However, the design of the ASR module was overall acceptable for the ATCOs and also many		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>improvement ideas have been gathered to further enhance the system.</p> <p>EXE 007</p> <p>ATCOs (100%) provided positive feedback on usability of the ASR system. Some concerns due to unfamiliarity in using the pedal to activate the ASR, also were reported.</p> <p>Overall, ATCOs were confident about using ASR and would like to use it frequently. They found ASR easy to use and its functions well integrated. Half the ATCOs agreed that they would need initial support in order to</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						be able of effectively using the system, and most of them agreed that some training on the system would be required, to understand how the tool "behaves" and also to learn how to proactively adapt their speech to ASR. Generally, the system wasn't found complex, and no inconsistencies were reported.		
				CRT-05.972-TLR4-TVALP-H106-2017	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise (004): The majority of the ATCOs had some difficulties to think of this validation as a technical one given the seemingly highly operational context and scenarios. In this environment they did not feel		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>comfortable using the system as there were issues with reliability and accuracy in recognition.</p> <p>EXE 007: ATCOs provided positive feedback on acceptance of the ASR tool in 94% of cases. Moreover, 100% of ATCOs judged acceptable the frequency of wrong highlighted callsign and frequency of wrong recognised ASR commands, as well as the tool's latency, considering the traffic scenario under evaluation</p>		
				CRT-05.972-TLR4-TVALP-H106-2014	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-	Indra-HC exercise (004): The validation platform setup was also missing some inputs/instructions that often are		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
					TRL4-TVALP-ASR-007	<p>performed, but those were not in the predefined list of clearances and did not have any impact on strip status (i.e. “backtrack” or “joint traffic circuit” were frequently used but those instructions did not create an event to update the flight strip)</p> <p><u>EXE 007</u></p> <p>ATCOs (100%) provided positive feedback on adequacy of ASR feedback.</p> <p>It was indicated that when using the system, ATCOs feel like they are provided with increased required information, compared with the amount they have</p>		





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						normally available and which they should look for on their own; as a result they were able to better plan their work		
				CRT-05.972-TLR4-TVALP-H106-2015	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	See row 149 <u>EXE 007</u> ATCOs (100%) provided positive qualitative feedback on callsign and command recognition rate. Four out of six ATCOs (nearly 70%) reported that the callsign rejection rate and command rejection rate were acceptable During the debriefings, controllers mentioned they were happy with the ASR recognition rate		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						and that it contributes to the high trust in the ASR system. See row 151		
				CRT-05.972-TLR4-TVALP-H106-2017	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	<u>EXE 007</u> ATCOs provided positive feedback on acceptance of the ASR tool in 94% of cases. Moreover, 100% of ATCOs judged acceptable the frequency of wrong highlighted callsign and frequency of wrong recognised ASR commands, as well as the tool's latency, considering the traffic scenario under evaluation		
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]		BENEFIT: In case ATCo utter an incomplete/wrong callsign, it would be helpful the ASR system correct/complete it and in case a wrong						ASR system shall complete/correct and highlight in a different colour the correct callsign in case of wrong/incomplete

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		clearance is issued other safety net shall intervene->						callsign utterance by ATCO
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	W2.PJ05.97-HP-ASR-41	Wrong recognised ASR command is not realised by ATCO with potential of Human Error increase: ATCO does not realizes the wrong command and the wrong command is automatically accepted by the system Potential of overreliance on the ASR tool support Consequent decrease of situation awareness and increase in human error This issue also affects argument: Arg. 1.2.3: Operating methods cover degraded modes of the ATM system. Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only] Arg. 1.3.3: The level of	OBJ-05.972-TRL4-TVALP-H106.2010	CRT-05.972-TLR4-TVALP-H106-2013	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise (004): Although situational awareness could not be addressed in the tests, ATCOs expressed their concerns that this solution could negatively impact their SA. During the reference scenario they felt that they had the opportunity for "self-check". However, with the ASR scenario the feeling of checking themselves was lost as the system took over the manual input after they provided the clearance or instruction. But if they have to continuously check the system, according to the	ASR system further enhancement may be developed to support AIR-GND communications for callsign highlight and clearance readback conformance monitoring	
								95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
							ASR clearance recognition function may be limited t not safety critical clearances to avoid increase in potential for	

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
Arg. 2.3.8: The user interface	W2.PJ05.97-HP-ASR-39	workload (induced by cognitive and/or physical task demands) is acceptable.	OBJ-05.972-	CRT-05.972-		ATCOs, no actual progress has been made in terms of workload reduction.	human error. Further assessment is required	
						EXE 007	ASR system should be implemented in environment provided with safety net tools such as conflicting clearance detection tools	
						Four out of six ATCOs (nearly 70%) responded that the ASR does not increase the potential for human error compared to current operations.		The ASR HMI shall enable manual correction/update of automatically proposed command value/type.
						During the debriefings, ATCOs provided positive general feedback for the ASR system, and no negative comments were given when asked about the system's potential to increase human error.		
Arg. 2.3.8: The user interface	W2.PJ05.97-HP-ASR-39	BENEFIT: ASR increases situation	OBJ-05.972-	CRT-05.972-	EXE-05.97.2-TRL4-TVALP-	In the Indra-HC exercise (004),		

ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
supports a sufficient level of individual situation awareness. [V1: AIR only]		awareness highlighting callsign based on ATCO-Flight R/T. This might also affects ATCO productivity	TRL4-TVALP-H106-2010	TLR4-TVALP-H106-2012	ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	<p>ATCOs welcomed the callsign highlight functionality, which helped to visually emphasize the strip related to the aircraft in the EFS bay. This was regarded as a potential situational awareness enhancing functionality.</p> <p><u>EXE 007</u></p> <p>100% of ATCOs responded that ASR supports ATCO in maintaining an adequate level of situation awareness.</p> <p>Moreover, it was indicated that when using the system, ATCOs feel like they are provided with</p>		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>increased required information, compared with the amount they have normally available and which they should look for on their own; as a result they were able to better plan their work. The 'Hook' function was reported to help improving situational awareness. All ATCOs rated situational awareness as either 'high' or 'perfect' during solution scenarios, which suggests that controllers were generally satisfied about their situational awareness levels when using ASR.</p> <p>Some improvements were also identified - see the</p>		





ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						recommendations associated.		
Arg. 3.3.1: Intra-team and inter-team communication supports the information requirements of team members.		BENEFIT: ATCOs might improve the adherence to the phraseology if they have a good user experience through ASR support			To be assessed in next phase			
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.		•Job acceptance and satisfaction might be reduced in case of abnormal and degraded mode (malfunction) or low system performance (e.g. need of continuously update wrongly recognised clearance, long time wait before showing the recognised clearance)			To be assessed in next phase			95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.	W2.PJ05.97-HP-ASR-46	BENEFIT: ASR input device increases job satisfaction by providing an interaction means that is intuitive (adherent to daily life user experience e.g. car speech recognition system, smartphone speech recognition	OBJ-05.972-TRL4-TVALP-H106.2030	CRT-05.972-TLR4-TVALP-H106-2031	EXE-05.97.2-TRL4-TVALP-ASR-004 EXE-05.97.2-TRL4-TVALP-ASR-006 EXE-05.97.2-TRL4-TVALP-ASR-007	Indra-HC exercise(004): As the simulation's TRL level was somewhere between a laboratory test and an operational environment, it		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
		systems). This might also affects argument: Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]				was difficult to talk about job satisfaction. ATCOs highlighted the need to further improve the vocabulary. It was also advised to record the voice of the whole Hungarian TWR ATCO staff in order to optimise the recognition. If the system is fully reliable, it could decrease workload significantly. However, it could also reduce situational awareness significantly, and could lead to confusion. Another role for ASR has been envisaged (see above). EXE006: ATC should see in the baseline the		



ARG.	IS/BEN_ID	Issue/BEN	HP Val obj ID	Suc criteria ID	EXE/Activity	Evidence Description	REC	REQ
						<p>switch on/off function</p> <p><u>EXE 007</u></p> <p>94% of ATCOs passed positive feedback on the acceptance of the ASR tool. Moreover, 100% of ATCOs said the frequency of wrongly highlighted call signs and of incorrectly recognised ASR commands was acceptable, as well as the tool's latency, considering the traffic samples under evaluation in the scenarios.</p> <p>All ATCOs provided positive feedback on job satisfaction and acceptance.</p>		





Table 23: Summary of the ASR HP results and recommendations/ requirements for each identified issue & related argument

10.2 Maturity of the Solution

This section contains the HP maturity review at the end of the validation activity to give advice on the transition to the next TRL6-phase



Maturity checklist for finalising the V2/TRL4 assessment			
ID	Question	Answer <i>Fill in 'yes' or 'no'.</i>	Comments <i>Please substantiate your answer.</i>
1	Have relevant arguments for V2/TRL4 been addressed and appropriately supported?	Yes	See Section 5.6.1
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 V2/TRL4)?	Yes	See Section 5.6.1
3	Have potential interactions with related projects/concepts started to be considered?	Yes	No related SESAR solutions have been identified to be considered in the HP assessment for solution PJ05-97.2
4	In case of different options of the proposed solution, is the decision for a specific option(s) based on the consideration of HP benefits and issues?	N.A.	No different options proposed by the projects. There might be local implementation needs (e.g. automatic acceptance or operator acceptance of the recognized command).
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	See TVALR
6	Are the assessment 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	See Section 5.6.1
7	Has the proposed solution been tested with end-users and started to be tested under sufficiently realistic conditions, including certain abnormal and degraded conditions?	Yes	See Section 5.6.1



8	Are the outcomes based on the solution assessment mature enough to start V3/TRL6?	Yes	See TVALR
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSD, SPR)?	Yes	HPAR, SAR and TS/IRS have been updated after the collection of the project output
10	Have the major factors that can influence the transition feasibility (e.g. changes in automation level, changes in staff requirements, such as competence, staffing levels) been considered? Are there any ideas on how to overcome any such issues?	Yes	See Section 5.6.1
11	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	See section 5.1.6
12	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	See section 5.2.1



11 References

- [1] PJ.05 W2 DTT D3.1.022- Technical Requirements (TS/IRS) Final
- [2] PJ.05 W2 DTT D3.1.031- Technical Validation Plan (TVALP) Part I, Part IV
- [3] PJ.05 W2 DTT D3.1.051- Technical Validation Report (TVALR) Final
- [4] Human Performance - Guidance Reference Material 00.03.02 27 Aug 2020

Appendix A – Additional HP activities conducted

None

Appendix B – HP Recommendations Register²

The following table provides the identified HP requirements for PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower. ATM Scope of the solution is Ground.

Reference	Type	Recommendation	Rationale	Source	Solution	Status
REQ-05-W2-97.1-TS-VARH.2031	Human Performance, HMI	V/A-R Head-up display may provide alerts for conflicting aircraft	Head-up display of conflict improving user experience not having to search for information about where the conflict is and which a/c (call signs) are involved	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2032	Human Performance, HMI	V/A-R Head-up display may provide alerts for runway incursion	Head-up display of runway incursion improving user experience not having to search for information about where the conflict is and which a/c (call signs) are involved	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2033	Human Performance, HMI	Number of Information provided in the Head-Up HMI of V/A-R display should be predefined according to an initial minimum set and customisable by end-user in a user-setting profile	To ensure V/A-R tracking label provides adequate level of information	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2034	Human Performance	Usability of V/A-R systems should be further assessed	TRL4 results shows there might be issues with the usability of V/A-R systems	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented	To be analysed

² Please, refer to the HP-Log to find previous wording or exercise level proposed recommendations / rejected ones rational

Reference	Type	Recommendation	Rationale	Source	Solution	Status
					Reality applications for Towe	
REQ-05-W2-97.1-TS-VARH.2035	Human Performance	Acceptability of V/A-R system should be further assessed	TRL4 results shows there might be issues with the acceptability of the V/A-R system	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2036	Human Performance	Usability of V/A-R Air Gesture systems should be improved and further assessed	TRL4 results shows there might be issues with the usability of Air Gesture V/A-R systems	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2037	Human Performance	Usability of V/A-R Attention Guidance systems should be improved and further assessed	TRL4 results shows there might be issues with the usability of Attention Guidance V/A-R systems	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2038	Human Performance	Further investigation of impaired vision/switching attention between far and HoloLens close vision should be conducted	Recommendation of further investigation on impaired vision/switching attention between far and close vision and HoloLens	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.2039	Human Performance	Further investigation for shift from LOW VIS to Standard operations including different use cases should be performed	Recommendation on further investigation for shift from LOW VIS to Standard operations including different use cases (AC on the ground and approaching)	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.0139	Human Performance	Weight of the head-up display of V/-A/R head-up display should be feasible to be worn for an entire shift	Ergonomics of Head mounted display shall be ensured	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Table 24: PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower HP Recommendations

The following table provides the identified HP requirements for PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning. Scope of the solution is Ground.

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
REQ-05-W2-97.2-TS-ASRH.0016	Training	ASR system further development may support job training	Job training would be much easier for inexperienced controllers (to understand new ATC to stick to phraseology) or for those ATCs who haven't been in ops for a while. The ASR display mode is transparent and easily visible and errors are easily detected. Could replace simulation pilots. Also good help for the supervisors - good info for sups.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0017	System design	ASR system further development may support incident analysis	ASR display allows easier and faster access of the frequency communication. Based on ATC experience.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
	Training	Moved to a training requirement Provide appropriate training and exposure of the ATCos to the new system functionalities to achieve better understanding critical for building up trust into the new functionalities.	Disparities amongst ATCos in Europe regarding familiarity with automated tools - unified training at European level needs to be developed	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
REQ-05-W2-97.2-TS-ASRH.0019	System design	The ASR clearance recognition process should be processed during the ground-air communication to reduce the delay of the ASR clearance HMI display at the minimum possible. Initial estimation of acceptable delay is 1 second based on expert judgement	We do analyse during utterance; however, we only output if the output remains more stable; otherwise, the output would change during utterance; it is unclear which way is better for the ATCos; Many ATCos were ok with the speed.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0020	System design	The ASR recognition system engine should be based on real OPS communication data	Real OPS data are needed because ATCos behave (and speak) differently in simulation and in real ops .	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0021	System design	The ASR grammar engine should be as wide as possible to include phraseology deviations as much as possible	More samples of “gold” transcriptions are needed and annotations to automatically learn those deviations (rather than to model them by hand) since grammar is already fine	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
	System design	Local recommendations – Removed Runway bay handling to be improved.	It needs to be technically adjusted to be easier and faster to use for the ATCos. ATCs	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Removed
	System design	Local recommendations - Added a HMI Generic requirement Improvement of display colours.	To adjust display colours according to the ATCos so that their colours indicate the importance and type of message / command	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement
	System design	Local recommendations - Added a HMI Generic requirement Drag-and-drop functionality over borders of flight strip bays for individual planning purposes to be used.	Drag and drop functionality will help in individual planning. At the present moment in ASR is a bit more difficult because it is necessary to monitor data that ATC does not need at that moment.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
	System design	Local recommendations - Added a HMI Generic requirement Further improvement of strip system with visual flagging of callsign.	In the past, ATCOs used to push a flight strip to the left or to the right to make the work assignments more easier to spot. In this way, they separated the AC according to the degree of processing. Now the same could be achieved electronically. E.g. To push the left/right those strips that are a step towards transfer to another sector etc.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement
REQ-05-W2-97.2-TS-ASRH.002 2	System design	ASR system may be further developed to support ATCOs in other tasks in addition to clearance system input and callsign highlight (e.g. assuming traffic, activation/de-activation of stop bars, etc.)	ASR could automatically recognise and execute commands such as assuming traffic or activation/ de-activation of stop bars.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
	System design	Local implementation, a generic switch-on/switch-off function requirement has been added An alternative means for the use of the two keys, one for the activation of	During the simulation, two different keys on the keyboard were used - one for the activation of the ASR and the other for communicating on the radio frequency. This was found confusing and could increase workload and impact situational awareness according to ATCO.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local implementation, a generic switch-on/switch-off function requirement has been added

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
		the ASR and the other for communicating on the radio frequency shall be envisioned.		ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.			
	System design	Local recommendations - Added a HMI Generic requirement The background colours of the ASR pop-up window should be more evident.	The light grey colour of the 'pop-up' windows are not visible enough for the ATCOs, especially if the HMI display colour is similar.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement
	System design	Local recommendations - Added a HMI Generic requirement A more evident highlight the 'Hooked' aircraft on the HMI should be implemented.	When 'hooking' an aircraft, a small white circle appears around it to highlight it for the ATCO, however this was not easily distinguishable.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
				Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.			
	System design	Local recommendations - Added a HMI Generic requirement The 'Hook' function should be improved by allowing controllers to search aircraft by their type.	Some ATCOs claimed that it would be useful for ASR to allow ATCOs to look for aircrafts by their type.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	Local recommendations - Added a HMI Generic requirement
REQ-05-W2-97.2-TS-ASRH.0023	Operating methods	ASR should be automatically activated when switched on	Some ATCO prefer to have hands free and use the pedal, but some others found the pedal a bit outdated so there is no agreement so far on the best activation means.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
REQ-05-W2-97.2-TSSR-04.0002	System design	ASR should acknowledge the clearance uttered in a silent/passive manner with the time out.	To avoid disrupting the workflow when the automatic acceptance is available. (requirement created within TS/IRS Part II - SAR framework)	Interaction of ASR with A-SMGCS. PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0025	System design	ASR may be integrated with A-SMGCS to support additional functions such as display of taxi route cleared or runway status according to recognised clearance	ATCO s claimed that it would be useful if ASR would recognise and display the taxi route given to an aircraft by a controller or if it would display a RWY as 'occupied' when recognising that a vehicle using that RWY is in contact with the TWR. Also, ASR could also highlight a closed taxiway on the HMI.	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
	Training	Training requirement added Should foresee a dedicated ASR training.	ASR training would be useful both for experienced and inexperienced controllers for: 1) ATCO familiarisation with the tool behaviours to optimize the teaming for a more effective performance. 2) accustom ATCOs to strictly adhere to the standard ATC phraseology, and to use a dedicated subset of ATC command (as in the present validation exercise).	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected	
REQ-05-W2-97.2-TS-ASRH.0027	System design	Addressed in previous recommendation and in requirements	The ASR would allow the ATCO to activate safety barriers such as stop bars. .	PJ 05.97.2 - TRL4 - VALR related to exe EXE-5.97.2-TRL4-VALR-007 Assessment of efficiency of ASR Automatic Speech Recognition (ASR) in TWR environment. Interaction of ASR with A-SMGCS.	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-	System design	Electronic flight progress strip should be available	To maximize the benefit of having V/AR system, it should be available	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
ASRH.0028		when implementing V/A-R system	in EFPS environment to avoid ATCOs to fill-in paper strips		CWP supported by AI and Machine Learning		
REQ-05-W2-97.2-TS-ASRH.0029	Human Performance	Demand and fatigue should be further assessed in case of ASR use	Demand and fatigue might be reduced due to ATCO manual interaction reduction, but might also increase due to ATCO being less involved and performing more monitoring than acting.	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0030	Human Performance	ASR recognition system should be integrated in current CWP in order to use the local GND-AIR microphone as source of voice to achieve a good level of fidelity	The system recognising the instructions based on headset seems more robust	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0031	Human Performance	ASR system further enhancement may be developed to support AIR-GND communications for callsign highlight and clearance readback conformance monitoring	With the ASR system the ATCO feeling of checking themselves seems lost as the system takes over the manual input after they provided the clearance or instruction. Hear back Clearance monitoring function might enhance ATCOs' situation awareness	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ASRH.0032	Human Performance	ASR clearance recognition function may be limited to not safety critical clearances to avoid increase in potential for human error. Further assessment is required	ASR clearance recognition function may be limited to not safety critical clearances to avoid increase in potential for human error. Further assessment is required	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
REQ-05-W2-97.2-TS-ASRH.0033	Human Performance	ASR system should be implemented in environment provided with safety net tools such as conflicting clearance detection tools	ASR system should be implemented in environment provided with safety net tools such as conflicting clearance detection tools	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	
REQ-05-W2-97.2-TS-ReTi.0001	Performance	ASR should give a response not later than 1.0 second after the controller has pressed the push-to-talk-button, by sending the recognized callsign to the cooperating ATC system. Remark: If the callsign is not recognized after the callsign is said, ASR MAY send recognized callsign together with the whole recognized command even if it is recognized during the utterance (e.g. if ASR needs the other contextual information to recognize the callsign properly or the controller gives the callsign information at the end of the utterance). If a command is not started with a callsign, the callsign information may be sent first followed by the rest of the recognized command. If an utterance contains	Callsign is one of the most important information. If a long command is given (e.g. duration > 3 seconds), the controller wants an early feedback, that ASR has recognized the correct callsign. This could be immediately displayed by highlighting the aircraft label on the CWP HMI.	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	



Reference	Type	Recommendation	Rationale	Source	Solution	Status	Rejection
		more than one callsign (break, break), only the first callsign may be sent first.					
REQ-05-W2-97.2-TS-ReTi.0002	Performance	For 99.9% of the ATCO utterances except callsign itself, the system should be able to give the final speech-to-text and text-to-concept result latest one second after the ATCO has released the push-to-talk button.	There is a need to know the aircraft the ATCO is speaking to after the callsign is said. Sufficient response time has to be kept under all conditions even in case of long ATCO transmission. For the other 0.1% percent a reaction time of less than 3 seconds or a rejection with "NO_CONCEPT" is required.	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed	

Table 25: PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning HP Recommendations



Appendix C – HP Requirements Register³

The following table provides the identified HP requirements for PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower. ATM Scope of the solution is Ground.

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-AG01.0003	HMI	The Attention Guidance alerts shall be visible from all the angles in the tower.	To ensure Safety and User comfort, by allowing the visualization of the information from any place in the tower. (requirement created within the TS/IRS Part II - SAR framework)	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-AG02.0006	System design	Attention Guidance alert repetition The Attention Guidance system shall not repeat alerts once it is switched off by end user.	Attention Guidance alerts shall not be repeated once switched off by end user as they can annoy.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.0004	Functional	The tracking label shall be updated taking into account the new aircraft status. a) Once the aircraft has landed and is on ground, the label changes to the ground mode. b) Once the aircraft is airborne, the label changes to the airborne mode. c) Description on clearance displayed.	To present the information corresponding to the updated situation. (requirement created within the TS/IRS Part II - SAR framework)	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

³ Please, refer to the HP-Log to find previous wording or exercise level proposed requirements / rejected ones rational

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-VAR1.0006	HMI	The V/AR system shall indicate the depth of the real object by its presentation as part of the conformal information associated to it.	To help the clear identification of displayed objects. (requirement created within the TS/IRS Part II - SAR framework)	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.0007	Human Performance, HMI	The V/AR system shall display a visual indication of the limit of the augmented reality field of view in the Head-up display.	To help the end user to identify the field where the V/AR elements may be displayed. (requirement created within the TS/IRS Part II - SAR and Part IV - HPAR framework)	Ts/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-PERF.1012	Human performance	Conflicting clearances and runway incursions alerts reliability Reliability and timeliness of conflicting clearances and runway incursions alerts shall be ensured if available in the HMI V/A-R head up display.	To ensure Reliability and responsiveness of V/A-R system. Acceptable values to be investigated.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-PERF.1013	System design	Air Gestures reliability Reliability and timely responsiveness of V/AR Air Gesture interactions shall be ensured	To ensure Reliability and responsiveness of V/A-R system.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-PERF.1014		Attention Guidance measures reliability Reliability and timely responsiveness of V/AR attention Guidance measures shall be ensured.	To ensure Reliability and responsiveness of V/A-R Attention Guidance system. Acceptable values to be investigated.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.11010	Human Performance, HMI	Tracking labels not overshadowing The V/AR system shall display the tracking labels in a way that do not overshadow final approach path and initial climbing path.	Final approach path and initial departure path shall be clear to allow ATCOs monitoring.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-VAR1.11011	Human Performance, HMI	Tracking labels for not active traffic The V/AR system shall not display tracking labels for not active traffic in the Head-up display.	Tracking labels of traffic not in contact can disturb ATCOs with not needed information.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.1108	Human Performance, HMI	Information based on actual data The V/AR system shall display information in the Head-up HMI based on actual data.	The tracking labels and relevant aircraft information such as aircraft altitude, speed etc. shall be based on actual data to avoid misleading end-user.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.1109	Human Performance, HMI	Airport layers alignment The V/AR system shall display the airport layers in the Head-up HMI aligned with real world elements (e.g. RUNWAY, TAXIWAY, etc.).	To ensure V/A-R HMI is adequate to support ATCO in low visibility conditions.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.1012	OPS (operating methods / procedures)	V/AR status V/A-R status shall be displayed to ATCOs (e.g. malfunction, failure shall be displayed to ATCOs)	To ensure that the ATCO is aware if a technical problem occurs.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR1.1013	Human Performance, training	V/AR training ATOCs shall be extensively trained and exposed to the new system functionalities provided by V/A-R.	Training requirement	TRL4 Workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-VAR2.1101	Interoperability	The V/AR system shall be fed by primary identification tools (e.g. radar, ADS-B).	To enable the usual detection of flights, as well as the detection of unexpected flights in the area of responsibility where ATC service is being provided. (requirement created within the TS/IRS Part II - SAR framework)	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR2.1102	Human Performance, HMI	The V/AR system shall allow the customisation of the brightness of the V/AR displayed elements and saved in a user set profile.	To ensure V/A-R HMI is adequate to support ATCO	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR2.1102	Human Performance	The V/AR system shall allow the customisation of the brightness of the V/AR displayed elements and saved in a user set profile.	Such as Tracking Labels background and the text. V/AR displayed elements may appear too brightly on top of the background, disturbing the operator. (requirement created within the TS/IRS Part II - SAR and Part IV - HPAR framework)	Ts/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR2.1103	Human Performance	The V/AR system shall allow the customisation of the information provided in the Tracking Labels from a list of predefined set of information and saved in a user profile.	Customisation of tracking labels- user can choose option from few available. Full customisation is not recommended due to safety issues / certification	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.1101	Human Performance	Operating methods for V/AR Operating methods for V/A-R shall be established for normal, abnormal and degraded mode.	There is the need to define operating methods for all operating conditions and especially in low visibility conditions.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-VARH.1106	Human Performance, HMI	Tracking labels background colour The V/AR system shall display the tracking labels and attention guidance alerts with a background colour that do not overshadow the real world view.	It shall be avoided that the ATCOs does not see manoeuvring area.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.1108	Human Performance, HMI	V/A-R HMI shall provide tracking labels and additional elements locally established in the Head-up display in all visibility conditions	To ensure V/A-R HMI is adequate to support ATCO in all visibility conditions	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.1109	Human Performance, HMI	V/A-R HMI shall provide overlays of airport elements and additional The V/AR system shall allow the customisation of the brightness of the V/AR displayed elements and saved in a user set profile. locally established in the Head-up display during low visibility conditions or when required by end-user	To ensure V/A-R HMI is adequate to support ATCO in low visibility conditions	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VARH.1010	Human Performance, HMI	Tracking labels displayed in the Head-Up HMI shall not overlap between each others	It shall be avoided that the TL overlaps each other without allowing readability of the V/AR system shall allow the customisation of the brightness of the V/AR displayed elements and saved in a user set profile. and possibly affecting ATCO situation awareness	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0013	Human Performance	Weight of the head-up display of V/-A/R head-up display shall be feasible to be worn for an entire shift	Ergonomics of Head mounted display shall be ensured	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.2-TS-VARH.0014	Human Performance	Reliability and timeliness of V/A-R displayed data shall be ensured	To avoid V/A-R data based on live data not reliable (e.g. data dropouts during final approach)	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0016	Human Performance	Recovery operating procedures shall be defined in case of failure of V/A-R in all operating conditions.	It must be avoided that failure of V/A-R negatively affects the situation awareness.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0018	Human Performance	Non-intrusive alerts Conflicting clearances and runway incursions alerts shall not be intrusive if available in the HMI V/A-R head up display	It shall be prevented to provide intrusive alerts to ATCOs.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0019	Human Performance	Information size customisation The V/AR system shall allow the customization of the information presented size and the saving in a user setting profile.	V/A-R system images may appear too big or too small for the operator and they need to be customisable by the end-user	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0021	System design	V/AR display limitations Limitations of use of V/AR Head-Up display shall be assessed and defined.	V/A-R Head-Up display may be not usable at night due to the darkness of the display.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0022	Human Performance	V/AR dark display Dark and coated V/AR Head up display shall not affect real word visibility in good visibility conditions.	The fact that the V/AR device lens may be dark (like sunglasses) might reduce the ability to quickly view head down information.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0023	Human Performance	Non-intrusive attention guidance measures The V/AR system shall present conflicting clearances and runway incursion alerts in a non-intrusive manner (if available) in the Head-up display.	It shall be prevented to provide intrusive alerts to ATCOs.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.2-TS-VARH.0027	System design	Algorithm shall support smooth movement of real-time data labels	Algorithm should support smooth movement of real-time data labels (this is already technically feasible, but hasn't been tested in the current validation)	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.2-TS-VARH.0029	System design	Tracking labels consideration Tracking labels shall not be considered as primary source of information	Tracking labels are not considered as primary source of information. The system should be considered as a supporting tool.	TRL4 Post simulation workshop	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-AG02.0001	Functional, HMI, Performance	The Attention Guidance system shall identify the operator's attention focus on the airport traffic situation.	Knowing of the operator's attention focus is essential to enable further assessment of attention guidance measures. The method of the detection is hereby up to the specific implementation (e.g. via eye-tracking or algorithmic assessments)	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-AG02.0003	Functional, HMI	The Attention Guidance system shall adapt and/or trigger the display of visual elements on the situation data display to the controller.	To guide the operator's attention, the display of visual cues is a common approach. The attention guidance function shall therefore trigger the corresponding HMI function.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-AG01.0004	Functional, HMI, Performance	The Attention Guidance system shall provide a toggle mode (to switch on/off Attention Guidance functionality) in order to not disturb regular controller operations, to allow a clear interpretation of the information displayed, and to enable easy interaction for the user.	The system shall provide a toggle mode (to switch on/off Attention Guidance functionality). If the controller does not need support of the Attention Guidance system in any specific moment due to controller comfort, the activity is too low, more than 1 out of 20 alerts presented to the controller are false alerts, or the activity is so high that the controller feels disturbed by the amounts of warnings that can come to hide existing systems functions, the system must offer a function for switching the visible Attention Guidance elements off/on by the controller.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR01.0001	Functional, HMI, Performance	The V/AR system shall depict conformal information as overlapped to the real object it is associated to.	The user can rely on the head-up conformal view when it is consistent with the real out-of-the tower view. Misalignment producing big offset of V/AR objects would make the system not acceptable. Thus, the capability to display conformal data is crucial for the V/AR system.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed



Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-VAR01.0002	Functional, HMI, Performance	The V/AR system shall not obstruct the natural field of view of the ATCO with augmented reality elements.	In good visibility conditions, the V/AR system is intended to enhance the real view perceived by the ATCO and not to replace it, thus the augmented reality elements should not reduce the natural field of view of the ATCO.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR01.0003	HMI, Performance	The V/AR system shall be able to avoid cluttering of synthetic overlays that may obstruct the real view or overlap with other information.	Clutter is an important issue in HMI design, especially when Augmented Reality Technology is considered. Decluttering functions can be implemented in order to display the information without disturbing the view of other objects within the user's field of view. Sizing and transparency of overlays can be set according to the level of cluttering that can be tolerated.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed



Reference	Type	Requirement	Rationale	Assessment	Solution	Status
REQ-05-W2-97.1-TS-AG01.0002	HMI, Performance, Safety	The Attention Guidance shall set different escalation (intensity) levels for the critical events under consideration (e.g. conflicts).	In order to make sure that the most important information catches the controller's attention before anything else, the AG shall comprise different escalation levels for the visual elements. The Attention Guidance approach does not intend to create new alarms or alerts but to adapt existing visual alerts tailored to the traffic situation and the controller's attention focus. The different escalation levels are based on input from the existing alerting system that prioritizes all incoming safety net alerts.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed
REQ-05-W2-97.1-TS-VAR01.0004	Functional, HMI	The V/AR system shall have at least 30° x 15° minimum field of view for the augmented viewing port.	The field of view of the augmented viewport should be large enough (30° x 15° minimum FOV) to intersect a wide portion of the out of the tower view in order to avoid excessive movements of the user's head.	TS/IRS	PJ.05-W2-97.1: Virtual/Augmented Reality applications for Towe	To be analysed

Table 26: PJ.05-W2-97.1: Virtual/Augmented Reality applications for Tower HP Requirements

The following tables provides the identified HP requirements for PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning. ATM scope of the solution is Ground.

Reference	Type of requirement	Requirement Proposed rewording	Rationale	Assessment source + Reference report	Solution involved	Req status
REQ-05-W2-97.2-TS-HMI0.0002	Human Performance, Design	AI feed callsign recognition levels visualisation ASR HMI shall highlight the recognised callsign in a different colour in case of uncertainty in callsign recognition in a range of percentage to be assessed.	in case the ARS has fully recognized input the colour coding should be different than if there was some AI input – this should be further investigated	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-HMI0.0106	Human Performance, Design	Callsign recognition uncertainty ASR HMI shall not highlight any callsign in case of uncertainty in callsign recognition is above a percentage to be defined locally.	In case of the system recognising a wrong callsign it's better to not show anything rather the wrong recognized callsign.	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-HMI0.0007	Human Performance, HMI	ASR integration in CWP HMI ASR system HMI shall be integrated in CWP HMI (EFPS or other locally established HMI) in a coherent and visible way.	ASR HMI shall be in the scan path of the end user and shall be coherently integrated	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-Perf.0008	Human Performance, Design	Impact on CWP ASR system shall be integrated in current CWP system without affecting what already available.	The ASR must not introduce changes to already available systems.	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0001	OPS (operating methods / procedures)	Delay between the voice communication and the displayed feedback shall be reduced to the possible minimum and shall be subject to ATCOs' acceptability.	Delays in displayed feedback can slow down important decisions in a planned AC separation or any other aspect of the ATC decision.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed

Reference	Type of requirement	Requirement Proposed rewording	Rationale	Assessment source + Reference report	Solution involved	Req status
		Initial acceptable assessed value is 1s		controller productivity by ASR at the TWR CWP)		
REQ-05-W2-97.2-TS-ASRH.0002	OPS (operating methods / procedures)	ATCO's callsign voice communication shall be automatically highlighted by ASR system in the CWP HMI during ground-air R/T exchanges	To make it easier to get to the desired flight data at any time.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0003	System design	ATCO's clearance voice communication shall be automatically recognised by ASR system and displayed in the CWP HMI during ground-air R/T exchanges	To make it easier to get to the desired flight data at any time.	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-HMI0.0006	OPS (operating methods / procedures)	ASR switch on/off ASR system shall provide the ATCO with switch on/switch off function	If the ASR recognition rate drops down, ATCO's workload might be higher than without using an ASR system. Therefore the switch on/off functionality is needed.	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-SDM: Improving controller productivity by ASR at the TWR CWP)	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-HMI0.0005	OPS (operating methods / procedures)	ASR failure indication The HMI shall display the ASR status (e.g. operational, malfunction, failure).	If the ASR completely fails, the controller needs to be informed about this as workflows might be affected and a higher level of manual	PJ5.97.2-TRL4-VALR related to EXE-5.97.2-TRL4-VALR-006 (POI 0040-	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and	To be analysed

Reference	Type of requirement	Requirement Proposed rewording	Rationale	Assessment source + Reference report	Solution involved	Req status
			input might be required. ASR failure is not related to misrecognitions, but to a complete shutdown of ASR support.	SDM: Improving controller productivity by ASR at the TWR CWP)	Machine Learning	
REQ-05-W2-97.2-TS-ASRH.0006	Human Performance, training	ASR training ATOCs shall be extensively trained and exposed to the new system functionalities to ASR benefits and adequate trust	Disparities amongst ATCOs in Europe regarding familiarity with automated tools - unified training at European level needs to be developed	TRL4 Workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	Rejected
REQ-05-W2-97.2-TS-ASRH.0007	Human Performance, System	Electronic flight progress strip shall be available when implementing ASR system	EFPS is a prerequisite of ASR	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0009	Human Performance, HMI	ASR HMI colours and brightness ASR system HMI colours and brightness shall be locally established following HF principles and local implementation needs.	ASR colours and brightness need to be consistent with local environment (e.g. LOCAL CWP colours shall be used to define the HMI Highlight background colour that shall be evident respect to not highlighted callsigns).	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0011	Human Performance, Design	95% of Reliability, accuracy and timely responsiveness rate of ASR system shall be ensured. Acceptable recognition rate, accuracy rate and latency shall be further assessed and defined	Assurance of reliability accuracy and responsiveness of ASR system shall be provided	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0012	Human Performance, Design	Working without ASR Local procedures and training shall be put in place to maintain ATCOs	There is the need to ensure recurrent training and local procedures to avoid ASR	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and	To be analysed

Reference	Type of requirement	Requirement Proposed rewording	Rationale	Assessment source + Reference report	Solution involved	Req status
		skills in working without ASR support to avoid ASR overreliance.	overreliance and keep ATCOs skills.		Machine Learning	
REQ-05-W2-97.2-TS-VARH.0011	Human Performance, HMI	The Attention Guidance system shall display the visual elements in a way that do not overshadow the final approach path and initial climbing path.	Final approach path and initial departure path shall be free to allow ATCOs monitoring	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-ASRH.0014	Human Performance, Design	ASR system shall complete/correct and highlight in a different colour the correct callsign in case of wrong/incomplete callsign utterance by ATCO	If ATCO utter a wrong callsign it would be helpful the system correct/complete it	TRL4 Post simulation workshop	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	To be analysed
REQ-05-W2-97.2-TS-HMI2.0002	Functional, HMI	The ASR HMI shall present the recognized command types together with the command values in the Electronic Flight Strip or in a dedicated place on the HMI.	The controller needs the information of the given command value in the Electronic Flight Strip or in a dedicated place on the HMI. Otherwise he has to manually input them.	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	
REQ-05-W2-97.2-TS-HMI0.0003	Functional, HMI	The ASR HMI shall enable acceptance of automatically inserted value by enabling automatic acceptance of recognized command values if the controller does not correct them within a predefined time frame to be locally established(e.g. 10 seconds).	Automatic acceptance of the recognised command if not corrected is required to avoid increase of ATCO workload	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	
REQ-05-W2-97.2-TS-HMI0.0004	Functional, HMI	The ASR HMI shall enable manual correction/update of automatically proposed command value/type.	If a command is not correctly recognized ATCO needs the possibility to manually correct it (e.g. by mouse or keyboard). ATCO is not able to repeat the clearance via	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	

Reference	Type of requirement	Requirement Proposed rewording	Rationale	Assessment source + Reference report	Solution involved	Req status
			voice. The manual input of ATCO (e.g. correction/update of command) SHALL have priority over automatically proposed command value/type within related utterance. Manual correction even makes sense, if recognized commands are manually confirmed, e.g. if four commands are given, all recognized command could be first accepted and then one is manually corrected. That is easier than rejecting all of them and then manual inserting all four.			
REQ-05-W2-97.2-TS-HMI0.0005	Functional, HMI	The ASR HMI shall indicate a failure of the ASR by displaying either an error message or using status icons.	If the ASR completely fails, the controller needs to be informed about this as workflows might be affected and a higher level of manual input might be required. ASR failure is not related to misrecognitions, but to a complete shutdown of ASR support.	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	
REQ-05-W2-97.2-TS-ReTi.0004	Performance	The ASR shall start with the recognition of the spoken language directly after the first word has been spoken.	To not lose time especially in case of longer utterance it would be beneficial if the system can already start with the recognition during the spoken commands.	TS/IRS	PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning	



<i>Reference</i>	<i>Type of requirement</i>	<i>Requirement Proposed rewording</i>	<i>Rationale</i>	<i>Assessment source + Reference report</i>	<i>Solution involved</i>	<i>Req status</i>
			Sometimes ASR system starts recognition when controller releases push-to-talk button. This behaviour should be avoided by this requirement.			

Table 27: PJ.05-W2-97.2: ASR at the TWR CWP supported by AI and Machine Learning HP Requirements



Appendix D – HP Log



W2_PJ05_97_HP_Log_
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