

# D4.1.020 PJ10-W2-96 ASR TS/IRS for TRL6 - Part IV - Human Performance Assessment Report

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# PROSA

## SOLUTION 96 ASR (AUTOMATIC SPEECH RECOGNITION)

This TVALR is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874464 under European Union's Horizon 2020 research and innovation programme.



### Abstract

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This document contains the Human Performance (HP) assessment report for the PJ.10-W2-Sol.96 ASR 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 V-phase..

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

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

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# 1 Executive Summary

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This Human Performance Assessment Report (HPAR) belongs to Solution 10-96 “Automatic Speech Recognition” and as such represents Part IV of TS/IRS. One online workshop and multiple WebEx-es were held with the exercise contributors as well as human performance experts, safety experts, operational experts and industry partners in order to complete the two first steps of the Human Performance (HP) assessment process, namely: Step 1 – Understand the concept: Reference, Solution and Assumptions and Step 2 – Understand the Human Performance Implications. The outputs of the two steps are summarized within this document.

The following activities have been planned for the Human Performance TRL6 validation of ASR:

- HP and Safety Change and Scoping assessment
- HP workshop
- Final HP and Safety workshop

The HP assessment comprises all five PJ.10-W2-Sol.96 ASR validation exercises which are fully described in the VALP Part I. Level of maturity of the concept at the start of the HP assessment was considered to be TRL4 aiming to reach TRL 6, therefore the argument structure for TRL6 was applied on the project respectively for all of the validation exercises that are:

- **EXE-PJ10.96-ASR-TRL6-VALP-001** performed by LDO: En-Route:

The exercise aims to reach a TRL-6 maturity.

The exercise was executed at LDO premises, located in Rome, in via Tiburtina. The ASR system was integrated in LDO’s next-gen CWP in order to support and improve the efficiency of ATCOs’ control tasks by input values in a set of appropriate datalink system masks that the ATCO is normally filling-in manually. The ASR used the content of R/T verbal communication to update the information concerning individual radar tracks, asking the ATCO to only approve it once it is filled. For this purpose, a set of valid ATCO clearances, instructions and routine tasks were identified, along with their HMI masks/features.

- **EXE-PJ10.96-ASR-TRL6-VALP-002** performed by DLR(AT-ONE), COOPANS:

The exercise 2 is divided into two interdependent parts that are dependent on each other (EXE-PJ.10-96-ASR-TRL6-02: Exercise 2a, EXE-PJ.10-96-ASR-TRL6-02: Exercise 2b,)

Validation criteria are speech recognition performance, i.e. word error rate (WER) and speech understanding performance, which includes evaluation of call-sign and command extraction performance.

In EXE-PJ.10-96-ASR-TRL6-02a the aim is to evaluate the human performance issues and ideal KPI values which are missing from wave 1. In this exercise the benefits of a (nearly) perfect ASR system will be quantified in the ops room. This will deliver operational quantified KPI values. Technically the executive controller will issue commands to the pilot via the Voice Communication System (VCS), but doing no mouse inputs into the system. The Executive controller, therefore, behaves just as when he/she is supported by an Automatic Speech Recognition System (ASR System). For safety reasons mouse inputs will be done by a second controller sitting next to him/her.

Big amount of data is crucial for the training of state-of-the-art speech recognition systems.

Therefore, data recording for the following EXE-PJ.10-96-ASR-TRL6-02b will also be conducted during this exercise. ACG/COOPANS with their controller conducts the experiment. CCL/COOPANS, ANS CR (B4), Integra and DLR (AT-ONE) evaluate the metrics.

In EXE-PJ.10-96-ASR-TRL6-02b the usage of a full functional ASR system was validated in an operational environment. In EXE-PJ.10-96-ASR-TRL6-02b first necessary data (Voice, Radar, Flight Plan) was recorded in the operational environment of Vienna approach. All available data is used to automatically train an ASR system considering the results of MALORCA\* and especially of the HAAWAI1 projects and to compare ASR performance of this trained ASR system and a conventional ASR system developed in wave 1. In this exercise the ops room data will be fed into the ASR-Module and the results will deliver ASR performance of real Speech Recognizer and not of a perfect ASR system as in Exe 002a. This enabled to determine operational KPI values. ACG/COOPANS is responsible for data recording, DLR (AT-One) for command prediction and developing and maintaining the data repository ANS-CR (B4) (Integra) evaluates the Safety impacts and CCL/COOPANS leads the Human Performance Part.

\* *DI-1: MALORCA Operational Concept Document (edition 3.00)*

#### **EXE-PJ10.96-ASR-TRL6-VALP -003** performed by ENAIRE:

In Exe-003 ENAIRE together with CRIDA and INDRA use automatic speech recognition, ASR, technology to support En-route controllers in their tasks. The ASR technology is integrated in a SACTA operational platform, including the operational communication system between controller and aircraft.

The exercise follows two complementary approaches:

The first approach seeks the operational feedback from controllers by means of a Real Time Simulation. ATCOs controlled a sector performing their task as usual with and without the automatic speech recognition system enabled. Pseudo-pilots managed flights and interacted via voice with the controllers. Subjective feedback was gathered by means of questionnaires, debriefings and observations. Objective data regarding system performance was recorded. The real time exercise took place at Crida's premises in Madrid.

The second approach obtained statistically significant objective data regarding the ASR performance. Operational recordings from real communications between ATCOs and Pilot coming from different Spanish sectors were processed through the ASR system to obtain accuracy on call-sign identification and event annotation.

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<sup>1</sup> HAAWAI project is the follow-up project of MALORCA starting in June 2020 with old and new partners (HAAWAI = Highly Automated Air Traffic Controller Working Position with Artificial Intelligence Integration)



Intermediate steps were scheduled to support the evolution of the concept and prototype. A dry-run with an early prototype was performed in November 2020. The outcome was used to improve the approach.

The exercise aims to reach a TRL-6 maturity as a pre-industrial prototype was integrated in an operational platform, including the operational communication system, and operational recordings were used.

- **EXE-PJ10.96-ASR-TRL6-VALP -005** performed by SINTEF:

In ASR-Exe-005 SINTEF (NATMIG) explored how ASR (in combination with traditional navigation in 2D and 3D visualizations of the air space) can be used to enhance the ATCOs' understanding of the dynamic changes in the air space configuration (DAC), including how these changes influence the traffic the ATCOs will control. ASR was used to enable faster and more predictable navigation in the 3D visualization of the air space and traffic, both through using bookmarks and free navigation. The exercise was run in cooperation with solution 44 (PJ09), conducted by ENAV (through solution 44) and SINTEF (NATMIG) (through solution 44 and 96), and is a continuation of work conducted in Wave 1 (in cooperation between PJ08-01 and PJ16-04).

The operational environment was the MILAN ACC, En-Route environment.

These activities were performed according to the Validation Objectives, which also comprise Human Performance aspects taken from the current HP Assessment Plan.

## 2 Introduction

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### 2.1 Purpose of the document

The purpose of this document is twofold:

- To describe the result of the activities conducted to date according to the HP assessment process Error! Reference source not found. in order to derive the HP Assessment Report for PJ.10-W2-Sol.96 ASR.
- To present the resulting plan of the recommended HP activities required to address the HP arguments relevant for the Solution along with the specific HP issues and benefits identified from the application of the HP assessment process.

### 2.2 Intended readership

The other members of the Solution 96 including all exercise contributors and industry partners providing the technical systems and / or platforms: COOPANS, DLR (AT-ONE), ENAIRE, LDO, NLR (AT-ONE), INDRA, CRIDA and SINTEF are intended contributors for this document.

This document is generally intended for:

- o 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.
- o SESAR 3 JOINT UNDERTAKING (S3JU) as SESAR 2020 Programme coordinator.
- o SESAR 2020 PJ.05-W2 consortium members working in ASR activities in order to be aware of activities and methods developed since coherency and comparability of the validation results are ensured through all SESAR 2020 solutions within the project.
- o SESAR 2020 PJ.19 Content Integration whose task is to ensure consistency and comparability of validation results across all SESAR2020 solutions.
- o Any SESAR 2020 solution, who think they can use the development aspects of solution PJ.10-W2-96 ASR
- o ER4 Project HAAWAI members, in order to have a common and shared view on the Automatic Speech Recognition technology.
- o Academic Researchers in the fields of the four main concepts developed as part of PJ.10-W2-96 - Automatic Speech Recognition
- o ANSPs: representatives of civil stakeholders
- o Affected employee unions
- o Airport owners / providers

- o      Airspace users

## 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

## 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 process described in detail in Error! Reference source not found. 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).

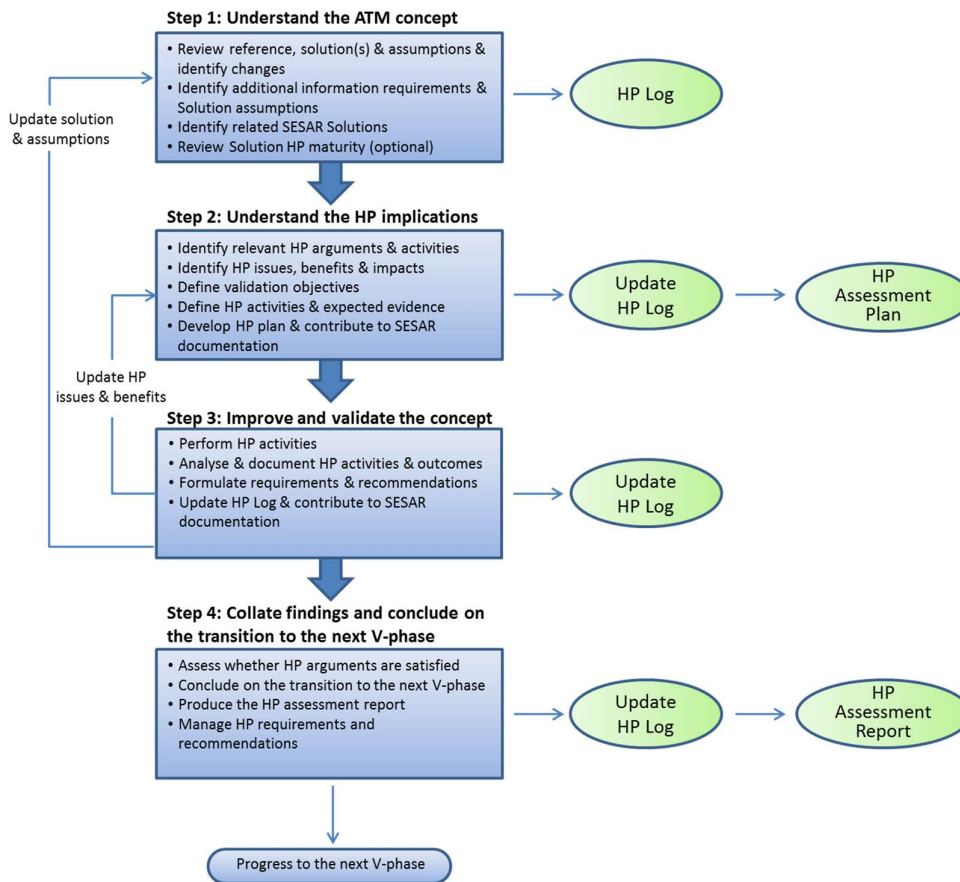


Figure 1: Steps of the HP assessment process

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 Error! Reference source not found..

The SESAR HP assessment process provides a framework to help ensure that HP aspects related to SESAR technical and operational developments are systematically identified and managed in the concept design, development and validation processError! Reference source not found.. The SESAR HP assessment process uses an 'argument' and 'evidence' approach. A HP argument is a '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.

Level of maturity of the concept at the start of the HP assessment was considered to be TRL6 for all four exercises. Therefore the argument structure for V2 was applied on the project. From the changes that would result from the improved performance in the provision of separation, it is concluded that ten of the twelve V3 second level HP arguments needed to be considered and satisfied in the HP assessment, namely:

1. Roles & Responsibilities
  - o Argument 1.2: The operating methods are clear, exhaustive and support human performance
  - o Argument 1.3: Human actors can achieve their tasks in normal, abnormal and degraded modes of operation
2. Human & System
  - o Argument 2.1: There is appropriate allocation of tasks between the human and the machine
  - o Argument 2.2: The performance of the technical system supports the human in carrying out their tasks
  - o Argument 2.3: The design of the HMI supports the human in carrying out their tasks
3. HP related transition factors
  - o Argument 4.1: Acceptance and job satisfaction
  - o Argument 4.5: Training needs are identified for affected human actors

Specific HP issues and benefits relating to the ASR tool for each of the relevant arguments are identified by performing a review of existing literature as well as conducting a series of HP issue and benefit

brainstorming sessions/interviews with relevant stakeholders including ATCOs, engineers, manufacturers, ANSP, safety and HF experts, and Real-Time Simulations. Over 22 potential HP issues/benefits are identified in total.

Based on the HP arguments and issues/benefits identified, several HP activities are recommended. The HP related validation activities conducted to date include:

- Interviews through WebEx with operational experts
- Dedicated F2F meetings with operational experts and relevant stakeholders
- Brainstorming sessions with relevant stakeholders
- Observations during the validation exercises
- 4 Real Time Simulations, one per exercise
- Joint HP and Safety Assessment Workshop with relevant stakeholders.

The output or 'evidence' collected from each of these activities that are relevant to the HP assessment are summarised in this report together with recommendations and/or requirements that have been proposed to help prevent or mitigate each of the potential HP issues identified. The HP recommendations and/ or requirements relate to each HP argument that had to be considered in the HP assessment for the operational concept under validation. These recommendations and requirements relate to the technical system, HMI and the training of the end user. In addition, HP recommendations for future validation activities that need to be conducted in the next V-phase in order to investigate the HP issues and benefits in more detail, as well as, potential mitigation are also provided.



## 4 Human Performance Assessment

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### 4.1 Step 1 Understand the ATM concept

#### 4.1.1 Description of reference scenario

Solution operational environment is En-Route and Approach Environment characterised by the following high-level features:

- Traffic
  - o Mixed types of aircraft
  - o VFR, IFR
- Ground ATM capabilities /Systems: FDP / EFPS / Voice COM / Data link communication
- En-route and APP sector:
  - o Low, Medium, and High complexity

EATMA defined roles involved in the reference scenarios are:

- o EXECUTIVE ATCO
- o PLANNER ATCO
- o SUPERVISOR POSITION
- o FLOW MANAGER POSITION

These roles are delivered by one single person.

#### 4.1.2 Description of solution scenario

The solution PJ10-96 ASR is focused on the Automatic Speech Recognition at En-route and Approach unit.

The solution scenario has the same characteristic of the reference scenario, except that the APP and en route 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”).

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.

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.

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

- o EXECUTIVE ATCO
- o PLANNER ATCO
- o SUPERVISOR POSITION
- o FLOW MANAGER POSITION

The solution PJ10-96 ASR is intended to be applied in Approach and En-route environments apart from local HMI needs and customization that requires further deployment assessment in TRL6 phase.

### 4.1.3 Consolidated list of assumptions

The following table summarises the consolidated assumptions:

Assumptions Title and Description	Source
PJ10-96, Automatic Speech Recognition	
<ul style="list-style-type: none"> <li>• Automatic Speech Recognition technology can support any kind of ATC Clearance</li> </ul>	W2-PJ10-96
<ul style="list-style-type: none"> <li>• General compliance by all actors with existing standards and guidelines</li> </ul>	W2-PJ10-96
<ul style="list-style-type: none"> <li>• Widely shared information among all necessary actors about key airport milestones.</li> </ul>	W2-PJ10-96
<ul style="list-style-type: none"> <li>• Separation standards and responsibilities unchanged.</li> </ul>	W2-PJ10-96
<ul style="list-style-type: none"> <li>• Validation activities should use reference scenarios to measure performance changes.</li> </ul>	W2-PJ10-96
Operating Methods / Traffic Characteristics	
<ul style="list-style-type: none"> <li>• General compliance by all actors with existing standards and guidelines</li> </ul>	W2-PJ10-96
Human actors	

<ul style="list-style-type: none"> <li>• Human actors are:             <ul style="list-style-type: none"> <li>o EXECUTIVE ATCO</li> <li>o PLANNER ATCO</li> <li>o SUPERVISOR POSITION</li> <li>o FLOW MANAGER POSITION</li> </ul> </li> </ul>	W2-PJ10-96
<ul style="list-style-type: none"> <li>• ATC have appropriate training and competencies.</li> </ul>	W2-PJ10-96
Training/ Licensing:	
<ul style="list-style-type: none"> <li>• Controllers are familiar with the operating environment and tools related to ASR.</li> </ul>	W2-PJ10-96

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

All identified relationships and dependencies with/on other projects/solutions are listed in the PMP section 6.1 [4]. For the HP assessment the following aspects are important:

Progressing the work of PJ.16-04 ASR and PJ.05-W2-Sol.97.2: the outcome of Solution PJ.10-W2-Sol.96 ASR assessment will be the baseline for the further HP work in the subsequent Solutions.

#### 4.1.5 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 PJ10.96 ASR. The changes have been identified through workshop involving solution members.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES	
1.1 ROLES & RESPONSIBILITIES	No changes are expected in the roles and responsibilities
1.2 OPERATING METHODS	No significant changes in operating methods in normal conditions; No change in Degraded conditions, eg. loss of ASR support; Decrease of situation awareness and increase of human error in degraded conditions, e.g. ASR recognizes a wrong clearance/call-sign (applicable for degraded conditions).

<p>1.3 TASKS</p>	<p>Change in tasks – ASR tool automatically points out call-signs and recognizes controller's clearance;</p> <p>Change in tasks – ASR tool automatically points out call-signs and recognizes flight crew utterances;</p> <p>Monitoring and controlling instead of manual interaction (by mouse/keyboard/digital pen);</p> <p>Manual correction action is expected in case of need;</p> <p>The changes are expected to provide benefits in terms of level of trust;</p> <p>Task performance: which might increase thanks to the automation support (task performance);</p> <p>Workload: which might decrease due to monitor and controlling support – provided by ASR. less task demands and less fatigue</p>
<p>2. HUMAN &amp; SYSTEM</p>	
<p>2.1 ALLOCATION OF TASKS (HUMAN &amp; SYSTEM)</p>	<p>Increased automation - flights that need to be cleared are highlighted and ASR tool gives automatic recognition of clearance (no need for input by mouse/keyboard/digital pen);</p> <p>Level of trust might be increased if the recognition rate is high gives more confidence to the controller;</p> <p>Human error might be potentially lessened with automatic highlight and clearance recognition.</p>
<p>2.2 PERFORMANCE OF TECHNICAL SYSTEM</p>	<p>Change in tasks – ASR tool automatically points out call-signs and recognizes controller's clearance;</p> <p>Change in tasks – ASR tool automatically points out call-signs and recognizes flight crew utterances;</p> <p>In case the performance of the technical system is not as expected in terms of recognition rate or time for output, this might increase ATCO frustration and might decrease situation awareness with</p>

	possible, consequent negative impact on workload and potential negative impact in case of overreliance.
2.3 HUMAN – MACHINE INTERFACE	Use of voice instead of hardware; Automatic highlight of flight displayed in the HMI; Automatic recognition of clearance displayed in the HMI; This is expected to improve workload, situation awareness and user satisfaction but these HP indicators might also be potentially negatively affected in case the performances of the technical system are not as expected or in case of degraded mode.
<b>3. TEAMS &amp; COMMUNICATION</b>	
3.1 TEAM COMPOSITION	No changes are expected in terms of team composition.
3.2 ALLOCATION OF TASKS	No changes are expected in terms of allocation of tasks.
3.3 COMMUNICATION	No changes are expected in communication, except more strict usage of the standard phraseology in order to have better ASR recognition rate
<b>4. HP RELATED TRANSITION FACTORS</b>	
4.1 ACCEPTANCE & JOB SATISFACTION	ASR tool might improve job acceptance and satisfaction in case of very good system performance with high recognition rate and in general smooth new technology might attract new ATCOs, but might also negatively affect both job acceptance and satisfaction in case of degraded mode (e.g. ASR recognizes a wrong clearance/call-signs )
4.2 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
4.4. RECRUITMENT AND SELECTION	No changes are expected in terms of recruitment and selection
4.5. TRAINING NEEDS	The controllers will need to be additionally trained for the use of ASR tool and its functionalities - but not significantly

**Table 2: Description of the change**

## 4.2 Step 2 Understand the HP implications

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

Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	Identifier evidence (Success Criteria)	Method
<b>1.2.5</b> Operating methods (procedures) can be followed in an accurate, efficient and timely manner.	HFI-ARG1.2.5-10.96_ASR_V2-001	<b>ISSUE:</b> Operating methods can't be followed in accurate, efficient and timely manner.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-001	To assess whether the role of the ATCO is consistent with human capabilities and limitations with the introduction of ASR	Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).	Real Time Simulation  SUS, Tailor-Made Questionnaires, Standardised workload questionnaire
<b>1.3.2</b> Tasks can be achieved in a timely manner.	HFB-ARG1.3.2-10.96_ASR_V2-001	<b>BENEFIT:</b> Potential for human error is reduced with automatic highlight and clearance recognition	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-002	Assess whether the user interface design positively impact productivity.	Potential changes to the end users tasks are achievable within an acceptable time frame (acceptable can be defined based on end users	Real Time Simulation  SUS, Tailor-Made Questionnaires

					opinion and good HF practice)	
	HFI-ARG1.3.2-10.96_ASR_V2-001	<p><b>ISSUE:</b> Wrong recognised ASR command is not realised by ATCO with potential of Human Error increase: ATCO does not realize the wrong command and the wrong command is automatically accepted by the system.</p> <p>Potential of overreliance on the ASR tool support.</p> <p>Consequent decrease of situation awareness and increase in human error.</p> <p><i>This issue also affects argument:</i></p> <p>Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]</p> <p>Arg. 1.3.3: The level of workload (induced by cognitive and/or physical task demands) is acceptable.</p>	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-003	Assess whether the user interface design negatively impact productivity.	Potential changes to the end users tasks are achievable within an acceptable time frame (acceptable can be defined based on end users opinion and good HF practice)	Real Time Simulation  SASHA,  Trust questionnaire
<b>1.3.5</b> <b>Human actors can maintain a sufficient level of</b>	HFI-ARG1.3.5-10.96_ASR_V2-001	<p><b>ISSUE:</b> The spare resources as task load is reduced due to support of ASR (no need for manual input) and therefore</p>	OBJ-PJ10.W2 S96 ASR	Assess positive effect on controllers' situational awareness.	Potential changes to situation awareness and the preliminary mitigation identified are acceptable	Real Time Simulation  SASHA,

<p><b>situation awareness.</b></p>		<p>positive impact on situational awareness.</p>	<p>TRL6-HPAP-004</p>		<p>(acceptable can be defined based on end users opinion and good HF practice relating to situation awareness).</p>	<p>Tailor-Made Questionnaires, Debriefing,</p>
	<p>HFB-ARG1.3.5-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> The tool recognises and displays all key elements of the clearance causing controllers increase in situation awareness and ability to accomplish tasks.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-005</p>	<p>Assess positive effect on controllers' situational awareness.</p>	<p>Potential changes to situation awareness and the preliminary mitigation identified are acceptable (acceptable can be defined based on end users opinion and good HF practice relating to situation awareness).</p>	<p>Real Time Simulation  SASHA and Tailor-Made Questionnaires</p>
	<p>HFI-ARG1.3.5-10.96_ASR_V2-00B</p>	<p><b>ISSUE:</b> The tool doesn't recognise and/or does not display all key elements of the clearance causing controllers decrease in situation awareness and ability to accomplish tasks.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-006</p>	<p>Assess negative effect on controllers situational awareness.</p>	<p>Potential changes to situation awareness and the preliminary mitigation identified are acceptable (acceptable can be defined based on end users opinion and good HF practice relating to situation awareness).</p>	<p>Real Time Simulation  SASHA and Tailor-Made Questionnaires</p>



<p><b>2.1.1</b></p> <p><b>The task allocation between the human and the machine is consistent with automation principles.</b></p>	<p>HFI-ARG2.1.1-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> The higher degree of automation might lead to deterioration of controllers' (core) skills.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-007</p>	<p>Assess whether the higher degree of automation associated with ASR leads to deterioration of controllers' (core) skills.</p>	<p>Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).</p>	<p>Real Time Simulation</p> <p>Debriefing</p>
<p><b>2.1.2</b></p> <p><b>Changes to the task allocation between human and machine support human performance.</b></p>	<p>HFB-ARG2.1.2-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> With the higher degree of automation, the ASR tool / functionality assists controllers in their monitoring tasks by freeing up cognitive resources (due to the call-sign highlights function.) This leads to an increase in controller efficiency.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-008</p>	<p>Assess whether the increase in automation level positively impacts controller efficiency - the monitoring task (due to the call-sign highlights function).</p>	<p>Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).</p>	<p>Real Time Simulation</p> <p>Debriefing, Bedford and Tailor-Made Questionnaires</p>
<p><b>2.1.3</b></p> <p><b>Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the</b></p>	<p>HFI-ARG2.1.3-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> The performance of the ATCO is affected by the unusual/degraded scenario in which ASR fails forcing a retour to manual.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-009</p>	<p>Assess whether a transition to manual modes and vice versa negatively impacts the controller performance.</p>	<p>Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback</p>	<p>Real Time Simulation</p> <p>Tailor-Made Questionnaires</p>

<p><b>human actors in a timely, efficient and accurate manner</b></p>					<p>to Human Factors Questionnaire).</p>	
<p><b>2.1.4</b>  The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.</p>	<p>HFB-ARG2.1.4-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> ASR reduces workload suggesting ATCO command based on ATCO-Flight R/T. This might also positively affect ATCO productivity.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-010</p>	<p>Assess whether the user interface design and required inputs positively impact the controller workload.</p>	<p>Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).</p>	<p>Real Time Simulation  Bedford and Tailor-Made Questionnaires</p>
<p><b>2.1.5</b>  Human actors can acquire an adequate mental model of the machine and its automated functions.</p>	<p>HFB-ARG2.1.5-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> The establishment of the controller's mental model could be positively affected by the higher degree of automation.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-011</p>	<p>Assess whether the level of automation positively impacts the controller workload.</p>	<p>The introduction of the ASR system into the context of application is operationally viable, ATCos workload with ASR shall be equal or better than in baseline (without ASR support).</p>	<p>Real Time Simulation  Debriefing</p>
<p><b>2.1.6</b>  The level of trust in automated</p>	<p>HFI-ARG2.1.6-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> General ASR recognition success rate affects controllers trust, therefore the controller does not cross-check the quality</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-012</p>	<p>Assess the level of trust into the tool/functionality and the positive impact for the controller's tasks.</p>	<p>The level of trust in the ASR system and its sub-systems and functions is appropriate (potential issues</p>	<p>Real Time Simulation  SATI, Tailor-Made Questionnaires, Debriefing,</p>

functions is appropriate.		of the output due to over-reliance.			related to trust and preliminary mitigations are identified).	Observations
<b>2.2.1</b>  The accuracy of information provided by the system is adequate for carrying out the task.	HFI-ARG2.2.1-10.96_ASR_V2-001	<b>ISSUE:</b> Incorrect highlight of aircraft / incorrect recognition of clearance in situations with a lot of clearances might not be accurate <b>ISSUE:</b> ASR tool failing to recognise combined clearances	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-013	To assess that the ASR usability is adequate and support ATCOs in performing their tasks	The accuracy of the information provided by the ASR system is adequate for the accomplishment of operations with respect to requirements in TS/IRS (Command Recognition Rate, command Recognition Error Rate).	Real Time Simulation  Tailor-Made Questionnaires,  Debriefing
<b>2.2.2</b>  The timeliness of information provided by the system is adequate for carrying out the task.	HFI-ARG2.2.2-10.96_ASR_V2-001	<b>ISSUE:</b> The timeliness of the information is not adequate for controllers to carry out their tasks, e.g. calculation results appear with delay, no update in opened interface display.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-014	Assess whether the impact of the ASR output timeliness on the controller performance is within acceptable limits.	The timeliness of the information provided by the ASR system is adequate for the accomplishment of operations. Controllers' feedback with respect to Human Factors questionnaire is better than for baseline.	Real Time Simulation  Tailor-Made Questionnaires,  Observations

<p><b>2.3.1</b></p> <p>The type of information provided satisfies the information requirements of the human.</p>	<p>HFB-ARG2.3.1-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> Increase of SA because the tool recognises and displays all key elements of the clearance.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-015</p>	<p>To assess that the ASR usability is adequate and support ATCOs in performing their tasks</p>	<p>Changes in the design of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks.</p>	<p>Real Time Simulation</p> <p>Tailor-Made Questionnaires</p>
<p><b>2.3.4</b></p> <p>Alarms and alerts have been developed according to HF principles. [V1: AIR only]</p>	<p>HFI-ARG2.3.4-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> The ASR warning/alert are not designed according to the HF/usability principles leading to an increase of the ops complexity.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-016</p>	<p>To assess that the ASR usability is adequate and support ATCOs in performing their tasks</p>	<p>Changes in the design of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks.</p>	<p>Real Time Simulation</p> <p>Tailor-Made Questionnaires, Debriefing</p>
<p><b>2.3.6</b></p> <p>The usability of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) is acceptable.</p>	<p>HFI-ARG2.3.6-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> The HMI is ambiguous and ATCOs are unsure whether their input is recognised/accepted by the system.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-017</p>	<p>To assess whether the changes in the design of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks.</p>	<p>Changes in the design of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks.</p>	<p>Real Time Simulation</p> <p>Tailor-Made Questionnaires Observations</p>
<p><b>2.3.7</b></p> <p>The user interface design reduces</p>	<p>HFB-ARG2.3.7-</p>	<p><b>BENEFIT:</b> Potential for human error is reduced with automatic</p>	<p>OBJ-PJ10.W2 S96 ASR</p>	<p>Assess the usability of the integrated tool/functionality interface.</p>	<p>Changes in the design of the user interface (input</p>	<p>Real Time Simulation</p>

<p><b>human error as far as possible. [V1: AIR only]</b></p>	<p>10.96_ASR_V2-001</p>	<p>highlight and clearance recognition</p> <p><b>ISSUE :</b> Wrong recognised ASR command is not realised by ATCO with potential of Human Error increase:</p> <p>ATCO does not realizes the wrong command and the wrong command is automatically accepted by the system</p> <p>Potential of overreliance on the ASR tool support</p> <p>Consequent decrease of situation awareness and increase in human error</p>	<p>V2-HPAP-018</p>		<p>devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks. ASR does not increase the potential for human error</p>	<p>Tailor-Made Questionnaires Observation</p>
<p><b>2.3.8</b></p> <p><b>The user interface design supports a sufficient level of individual situation awareness.</b></p>	<p>HFB-ARG2.3.8-10.96_ASR_V2-001</p>	<p><b>BENEFIT:</b> ASR increases situation awareness highlighting call-sign based on ATCO-Flight R/T. This might also affects controller productivity</p> <p><b>ISSUE:</b> Wrong recognised ASR command is not realised by ATCO with potential of Human Error increase: ATCO does not realize the wrong command and the wrong command is</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP-019</p>	<p>Assess the increase in individual SA.</p> <p>To assess that the technical systems for ASR support the ATCOs in performing their tasks</p>	<p>Changes in the design of the user interface (input devices, visual displays/output devices, alarm&amp; alerts) support ATCOs in carrying out the tasks.</p>	<p>Real Time Simulation</p> <p>SASHA</p>

		automatically accepted by the system				
<b>4.1.2</b>  The impact of changes on the job satisfaction of affected human actors has been considered.	HFB-ARG 4.1.2- 10.96_ASR_ V2-001	<b>BENEFIT:</b> 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).	OBJ- PJ10.W2 S96 ASR TRL6- HPAP-021	To assess job acceptance and satisfaction with the introduction of ASR	No negative impact with regard to changes in roles and responsibilities is envisaged or means for mitigating potential negative impacts are identified.	Real Time Simulation  Tailor-Made Questionnaires, Debriefing, Observations
<b>4.5.1</b>  The content of training for each actor group is specified. (V3 only)	HFI-ARG 4.5.1- 10.96_ASR_ V2-001	<b>ISSUE:</b> The training needs are not identified.	OBJ- PJ10.W2 S96 ASR TRL6- HPAP-022	Assess whether the additional training is needed.  To assess that the technical systems for ASR support the ATCOs in performing their tasks	Training types needed per actor group are identified	Real Time Simulation  Tailor-Made Questionnaires  Debriefing,  Observations
<b>4.5.3</b>  The required types of training (i.e. classroom, simulator, on-the job training) are identified. (TRL6 only)	HFI-ARG 4.5.3- 10.96_ASR_ V2-001	<b>ISSUE:</b> The required types of training (i.e. classroom, simulator, on-the job training) are not properly identified	OBJ- PJ10.W2 S96 ASR TRL6- HPAP-023	Assess whether the required types of training are identified.  To assess that the technical systems for ASR support the ATCOs in performing their tasks	Training types needed per actor group are identified	Real Time Simulation  Tailor-Made Questionnaires,  Debriefing,  Observations

Relevant arguments and associated EXEs are listed in the table below:

HP argument	Associated EXE
<b>Arg. 1.2: Operating methods (procedures) are exhaustive and support human performance.</b>	
Arg. 1.2.5: Operating methods (procedures) can be followed in an accurate, efficient and timely manner.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
<b>Arg. 1.3: Human actors can achieve their tasks (in normal &amp; abnormal conditions of the operational environment and degraded modes of operation).</b>	
Arg. 1.3.2: Tasks can be achieved in a timely manner.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003 EXE-10.96 ASR-TRL6-VALP-005
Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003 EXE-10.96 ASR-TRL6-VALP-005
<b>Arg. 2.1: There is an appropriate allocation of tasks between the human and machine (i.e. level of automation).</b>	
Arg. 2.1.1: The task allocation between the human and the machine is consistent with automation principles.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
Arg. 2.1.2: Changes to the task allocation between human and machine support human performance.	EXE-10.96 ASR-TRL6-VALP-001
Arg. 2.1.3: Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the human actors in a timely, efficient and accurate manner	EXE-10.96 ASR-TRL6-VALP-001
Arg. 2.1.4: The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003 EXE-10.96 ASR-TRL6-VALP-005
Arg. 2.1.5: Human actors can acquire an adequate mental model of the machine and its automated functions.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-003 EXE-10.96 ASR-TRL6-VALP-005
Arg. 2.1.6: The level of trust in automated functions is appropriate.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
<b>Arg. 2.2: The performance of the technical system supports the human in carrying out their task.</b>	
Arg. 2.2.1: The accuracy of information provided by the system is adequate for carrying out the task.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
Arg. 2.2.2: The timeliness of information provided by the system is adequate for carrying out the task.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
<b>Arg. 2.3: The design of the human-machine interface supports the human in carrying out their tasks.</b>	

HP argument	Associated EXE
Arg. 2.3.1: The type of information provided satisfies the information requirements of the human.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
Arg. 2.3.4: Alarms and alerts have been developed according to HF principles.	EXE-10.96 ASR-TRL6-VALP-001
Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003 EXE-10.96 ASR-TRL6-VALP-005
Arg. 2.3.7: The user interface design reduces human error as far as possible. [V1: AIR only]	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-005
Arg. 2.3.8: The user interface design supports a sufficient level of individual situation awareness.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-002
<b>Arg. 4.1: The proposed solution is acceptable to affected human actors.</b>	
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.	EXE-10.96 ASR-TRL6-VALP-001 EXE-10.96 ASR-TRL6-VALP-005
<b>Arg. 4.5: Training needs are identified for affected human actors. (TRL6 only)</b>	
Arg. 4.5.1: The content of training for each actor group is specified. (V3 only)	EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003
Arg. 4.5.3: The required types of training (i.e. classroom, simulator, on-the job training) are identified. (TRL6 only)	EXE-10.96 ASR-TRL6-VALP-002 EXE-10.96 ASR-TRL6-VALP-003

Table 4: Relevant HP arguments and associated validation exercises

### 4.3 Objectives and Success criteria summary

OBJID	OBJ Title	SCID	Success Criteria	HP objective
OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0010	To assess the technical feasibility of the integration of the ASR system and its sub-systems into CWP and interoperability between the ASR sub-systems and the existing	CRT-Sol.96ASR-TRL6-TVALP-0010.001	The ASR system and its subsystems and functions are able to integrate with the CWP systems and subsystems without negatively affecting the performance and availability of the	Not related



	CWP systems and tools.		existing CWP systems and tools.		
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0020</b>	To assess the stability of the ASR system performance.	<b>CRT-Sol.96ASR-TRL6-TVALP-0020.001</b>	The required ASR performance is maintained as required in TS/IRS (Command Recognition Rate, command Recognition Error Rate, etc.). <sup>2</sup>		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0020.002</b>	The required level of ASR performance does not show differences greater than 2.5% among the different command types tested in the exercises.		
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0030</b>	To assess the impact on the human performance of the integration of the ASR system and its sub-systems into operations in a realistic environment.	<b>CRT-Sol.96ASR-TRL6-TVALP-0030.001</b>	The introduction of the ASR system into the context of application is operationally viable, ATCos workload with ASR shall be equal or better than in baseline (without ASR support).	CRT-PJ10.W2 S96 ASR V2-HPAP-001  CRT-PJ10.W2 S96 ASR V2-HPAP-011	Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).
		<b>CRT-Sol.96ASR-TRL6-</b>	The accuracy of the information provided by the ASR system is	CRT-PJ10.W2 S96 ASR V2-HPAP-013	The accuracy of the information provided by the ASR system is

<sup>2</sup> According to REQ-10.96-01-TS-Perf.0010 and REQ-10.96-01-TS.0050 command recognition error rate of at most 2.5% and command recognition rate of at least 85% is required.-The rest is rejection rate.

		<b>TVALP-0030.002</b>	adequate for the accomplishment of operations with respect to requirements in TS/IRS (Command Recognition Rate, command Recognition Error Rate).		adequate for the accomplishment of operations with respect to requirements in TS/IRS (Command Recognition Rate, command Recognition Error Rate).
		<b>CRT-Sol.96ASR-TRL6-TVALP-0030.003</b>	The timeliness of the information provided by the ASR system is adequate for the accomplishment of operations. Controllers' feedback with respect to Human Factors questionnaire is better than for baseline.	CRT-PJ10.W2 S96 ASR V2-HPAP-002/003  CRT-PJ10.W2 S96 ASR V2-HPAP-014	Potential changes to the end users tasks are achievable within an acceptable time frame (acceptable can be defined based on end users opinion and good HF practice)/  The timeliness of the information provided by the ASR system is adequate for the accomplishment of operations. Controllers' feedback with respect to Human Factors questionnaire is better than for baseline.
		<b>CRT-Sol.96ASR-TRL6-</b>	The number and/or severity of human errors resulting from		

		<b>TVALP-0030.004</b>	the introduction of the ASR system is within tolerable limits, taking into account error type and operational impact. Furthermore more than 50% of command recognition errors and command recognition rejections are detected by the controllers and manually corrected.		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0030.005</b>	Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).	CRT-PJ10.W2 S96 ASR V2-HPAP-007/008/009	Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).
		<b>CRT-Sol.96ASR-TRL6-TVALP-0030.006</b>	Changes in the design of the user interface (input devices, visual displays/output devices, alarm& alerts) support ATCOs in carrying out the tasks.	CRT-PJ10.W2 S96 ASR V2-HPAP-015/016 / 017 /018/ 019	Changes in the design of the user interface (input devices, visual displays/output devices, alarm& alerts) support ATCOs in carrying out the tasks.

		<b>CRT-Sol.96ASR-TRL6-TVALP-0030.007</b>	The level of trust in the ASR system and its sub-systems and functions is appropriate (potential issues related to trust and preliminary mitigations are identified).	CRT-PJ10.W2 S96 ASR V2-HPAP-012	The level of trust in the ASR system and its sub-systems and functions is appropriate (potential issues related to trust and preliminary mitigations are identified).
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0040</b>	To assess the impact of the introduction of the ASR system on safety.	<b>CRT-Sol.96ASR-TRL6-TVALP-0040.001</b>	The accuracy of the information provided by the ASR system is adequate for the accomplishment of operations. Command Recognition Error Rate stays in the acceptable limits.		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0040.002</b>	The timeliness of the information provided by the ASR system is adequate for the accomplishment of operations.		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0040.003</b>	The number and/or severity of errors resulting from the introduction of the ASR system is within tolerable limits, taking into account error type and operational impact.		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0040.004</b>	The level of ATCo's situational awareness is not reduced with the	CRT-PJ10.W2 S96 ASR V2-HPAP-004/005/006	Potential changes to situation awareness and the preliminary

			introduction of ASR system (ATCo is able to perceive and interpret task relevant information and anticipate future events/actions).	CRT-PJ10.W2 S96 ASR V2-HPAP-017	mitigation identified are acceptable (acceptable can be defined based on end users opinion and good HF practice relating to situation awareness).
		<b>CRT-Sol.96ASR-TRL6-TVALP-0040.005</b>	The level of ATCos' workload is maintained or decreased with the introduction of ASR system.	CRT-PJ10.W2 S96 ASR V2-HPAP-011	The introduction of the ASR system into the context of application is operationally viable, ATCos workload with ASR shall be equal or better than in baseline (without ASR support).
		<b>CRT-Sol.96ASR-TRL6-TVALP-0040.006</b>	The recovery means for errors resulting from the introduction of the ASR system are identified to minimise operational impact.		
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0050</b>	To assess the impact of the introduction of the ASR system on safety.	<b>CRT-Sol.96ASR-TRL6-TVALP-0050.001</b>	The workload of ATCO after introduction of an ASR system is adequate to increase TMA capacity. The workload of ATCOs shall be less when working with ASR compared to baseline.		

		<b>CRT-Sol.96ASR-TRL6-TVALP-0050.002</b>	ASR allows ATCOs to safely manage a higher amount of aircraft, increasing the throughput in TMA.		
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0060</b>	To assess the impact of the introduction of the ASR system on Fuel efficiency	<b>CRT-Sol.96ASR-TRL6-TVALP-0060.001</b>	Aircraft will be able to improve their route Efficiency (fuel burnt) due to the higher throughput in TMA thanks to the introduction of ASR.		
		<b>CRT-Sol.96ASR-TRL6-TVALP-0060.002</b>	Aircraft will be able to improve their route Efficiency (flight time) due to the higher throughput in TMA thanks to the introduction of ASR.		
<b>OBJ-PJ.10-W2-96 ASR-TRL6-TVALP-0070</b>	To assess the impact of the introduction of the ASR in visualization navigation in Dynamic Airspace Configuration (DAC).	<b>CRT-Sol.96ASR-TRL6-TVALP-0070.001</b>	ATCOs are able to perform a faster and more predictable navigation when using ASR for 3D visualization.		

**Table 3: 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:

Exercise	Metrics	Indicators
001 / 002 / 003 / 005	ASR Recognition Rate	<ul style="list-style-type: none"> <li>-callsign recognition rate; callsign recognition error rate; -callsign recognition rejection rate</li> <li>-command recognition rate; command recognition error rate; command recognition rejection rate</li> <li>-ASR usage rate</li> </ul>

Table 4: Table of proposed HP sim data log and indicators

#### 4.4 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-10.96-TRL4-TVALP-ASR-001	EXE-10.96-TRL4-TVALP-ASR-002	EXE-10.96-TRL4-TVALP-ASR-003	EXE-10.96-TRL4-TVALP-ASR-005
<b>Workload</b>	Bedford and Tailor-Made Questionnaires	Bedford and Tailor-Made Questionnaires	NASA-tlx + Tailor-Made Questionnaires	Bedford and Tailor-Made Questionnaires
<b>Situation awareness</b>	SASHA	SASHA	SASHA	SASHA
<b>Acceptability</b>	CARS	Debriefing, Tailor-Made Questionnaires	CARS	Debriefing, Tailor-Made Questionnaires, Interviews
<b>Usability</b>	SUS	SUS, Tailor-Made Questionnaires	Tailor-Made Questionnaires	Tailor-Made Questionnaires, Interviews

<b>Trust</b>	SATI	SATI and Tailor-Made Questionnaires	SATI	SATI
<b>Human Error</b>	Tailor-Made Questionnaires	Tailor-Made Questionnaires	Tailor-Made Questionnaires + Observations	Tailor-Made Questionnaires, Interviews

**Table 5: 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:

Exercise	Metrics	Indicators
001 / 002 / 003 / 005	ASR Recognition Rate	<ul style="list-style-type: none"> <li>-callsign recognition rate; callsign recognition error rate; -callsign recognition rejection rate</li> <li>-command recognition rate; command recognition error rate; command recognition rejection rate</li> <li>-ASR usage rate</li> </ul>

**Table 6: Table of proposed HP sim data log and indicators**

## 4.5 Step 3 Improve and validate the concept

### 4.5.1 Description of HP activities conducted

The following tables summarises the conducted validation activities.

HP activity #	HP activity title	By when
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Activity 1.	Preliminary ASR HP assessment – HP approach	03 June 2020
Activity 2.	Joint HP & Safety Scoping and change Assessment Session	27 October 2020
Activity 3.	PJ10-96 ASR HPAP & HP-Log workshop	12 May 2021
Activity 4.	PJ.10-W2-96 ASR Final HPAP review workshop - validation objectives	10 September 2021
Activity 5.	Real Time Simulations <b>EXE001</b>	Q1 2021 - Q1 2022
Activity 6.	HPAR KoM	12 May 2022
Activity 7.	Real Time Simulations <b>EXE002</b>	Q1 2021 - Q1 2022
Activity 8.	Real Time Simulations <b>EXE003</b>	Q4 2021
Activity 9.	Real Time Simulations <b>EXE004</b>	Cancelled
Activity 10.	Real Time Simulations <b>EXE005</b>	Q3 2022
Activity 11.	HP Post-validations workshop	Q1 2023
Activity 12.		
Activity 13.		

**Table 7: Table of proposed HP activities and their priority**

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

<b>Activity 1.</b>	
Description	Joint HP& Safety Workshop
Related Arguments	ARG1.2. / ARG1.3 / ARG2.1 / ARG2.2 / ARG2.3 / ARG 4.1 / ARG 4.5
HP OBJECTIVES	Relevant arguments were addressed
Issues to be addressed / investigated from issues analysis	
Tool selected out of the HP repository	Focus group, Brainstorming

summary of the hp activity	03/June/2020
Planning and Approach	<i>An internal COOPANS workshop was organised in order to perform both preliminary HP and SAF scope/change assessment</i>
Resources	<i>HP experts, EXE contributors</i>
Timeline	<i>3 June 2020</i>

**Table 8: Description of Activity 1**

ACTIVITY 2.	
Description	Joint HP& Safety Workshop
Related Arguments	ARG1.2. / ARG1.3 / ARG2.1 / ARG2.2 / ARG2.3 / ARG 4.1 / ARG 4.5
HP OBJECTIVES	<p>HP and Safety scoping and change assessment</p> <p>Identify human actors likely to be impacted by the change &amp; assess changes in Arg. 1. Roles &amp; Responsibilities; Arg. 2. Human &amp; System; Arg. 3. Teams &amp; Communication Arg. 4. HP related Transition Factors.</p> <p>Identify/update HP issues and benefits</p>
Issues to be addressed / investigated from issues analysis	
Tool selected out of the HP repository	Focus group, brainstorming
Planning and Approach	A joint workshop was organised in order to perform both preliminary HP and Safety scope/change assessment and pre-assessment of use cases of changes in the different arguments.
Resources	HP experts, SAF experts, EXE contributors
Timeline	WS was held 27 October 2020

**Table 9: Description of Activity 2**

ACTIVITY 3.	PJ10-96 ASR HPAP & HP-Log workshop
Description	PJ10-96 ASR HPAP & HP-Log workshop
Related Arguments	ARG1.2. / ARG1.3 / ARG2.1 / ARG2.2 / ARG2.3 / ARG 4.1 / ARG 4.5
HP OBJECTIVES	Identify/update HP issues and benefits. Identify/update HP metrics.
Issues to be addressed / investigated from issues analysis	
Tool selected out of the HP repository	Focus group, brainstorming
Planning and Approach	To identify next steps for identifying HP issues as well all other relevant aspects concerning HP log and HPAP.
Resources	HP experts, SAF experts, EXE contributors
Timeline	2 May 2021

**Table 10: Description of Activity 3**

ACTIVITY 4.	PJ.10-W2-96 ASR Final HPAP review workshop - validation objectives
Description	HP Workshop
Related Arguments	ARG1.2. / ARG1.3 / ARG2.1 / ARG2.2 / ARG2.3 / ARG 4.1 / ARG 4.5
HP OBJECTIVES	Consolidation of the validation objectives
Issues to be addressed / investigated from issues analysis	
Tool selected out of the HP repository	Focus group, brainstorming
summary of the hp activity	
Resources	HP experts, SAF experts, EXE contributors
Timeline	WS was held 10 <sup>th</sup> September 2021

Table 11: Description of Activity 4

ACTIVITY 5.	Real Time Simulations EXE001
Description	<p>Real Time Simulations - EXE-10.96 ASR-TRL6-VALP-001 (LEONARDO, RTS)</p> <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"> <li>assistance to ATCO by prefilling an appropriate system mask (containing highlighted callsign information, clearances, orders and parameters, updated according to ATCO instructions) using verbal communication contents.</li> </ul> <p>The validation exercise simulated scenarios at Sofia ACC, in the En-Route environment.</p>
Related Arguments	See HP-Log
HP OBJECTIVES	
Issues to be addressed / investigated from issues analysis	See HP-Log
summary of the hp activity	See HP-Log
Tool selected out of the HP repository	<ul style="list-style-type: none"> <li>Workload: NASA TLX &amp; Bedford</li> <li>Situational Awareness: SASHA</li> <li>Acceptability/Trust: CARS or SATI</li> <li>Usability: SUS</li> </ul> <p>Post Run dedicated questionnaire and debrief procedure, including discussion on SA / acceptability / workload</p>
Timeline	Q3 2021 – Q2 2022

Table 12: Description of Activity 5

ACTIVITY 6.	HPAR KoM
Description	Kick of meeting and walkthrough of the way forward
Related Arguments	ARG1.2. / ARG1.3 / ARG2.1 / ARG2.2 / ARG2.3 / ARG 4.1 / ARG 4.5
Issues to be addressed / investigated from issues analysis	
Tool selected out of the HP repository	Focus group
Summary of the hp activity	Brainstorming
Timeline	12 <sup>th</sup> May 2022

**Table 13: Description of Activity 6**

ACTIVITY 7.	Real Time Simulations EXE002
Description	Real Time Simulations - EXE-10.96 ASR-TRL6-VALP-002 (COOPANS, DLR(AT-ONE))
Related Arguments	
HP OBJECTIVES	OBJ-Sol.96ASR-TRL6-TVALP-0030
Arguments & related issues addressed	Arg 1.2.5 Arg 1.3.2 / Arg 1.3.5 / Arg. 2.1.1 / Arg.2.1.4 / Arg.2.1.6 / Arg 2.2.1 / Arg 2.2.2 / Arg 2.3.1 / Arg 2.3.6 / Arg 2.3.7/ Arg 2.3.8 Arg 4.5.1 / Arg 4.5.3
Tool selected out of the HP repository	<ul style="list-style-type: none"> <li>• Workload: Bedford and Tailor-Made Questionnaires</li> <li>• Situational Awareness: SASHA</li> <li>• Acceptability/Trust: Debriefing, Tailor-Made Questionnaires</li> <li>• Usability: SUS, Tailor-Made Questionnaires</li> </ul>

	<ul style="list-style-type: none"> <li>• Trust: SATI and Tailor-Made Questionnaires</li> <li>• Human Error: Tailor-Made Questionnaires</li> <li>• Post Run and Post Simulation dedicated questionnaire and debrief procedure, including discussion on SA / acceptability / workload</li> </ul>
Timeline	Q4 2022
Required evidence	<ul style="list-style-type: none"> <li>- ASR recording/log data;</li> <li>- Standard and Customized questionnaires;</li> <li>- Observations;</li> <li>- Debriefings.</li> </ul>
Summary of the hp activity	<ul style="list-style-type: none"> <li>- Preparation of validation planning;</li> <li>- Platform testing</li> <li>- Preparation of validation planning;</li> <li>- Preparation of simulation environment;</li> <li>- Preparation of briefing material;</li> <li>- Preparation of questionnaires (and other data collection);</li> <li>- Execution of experiment;</li> <li>- Data collection and post simulation analysis of the results.</li> </ul> <p>This includes at least two different pre-validation trials (one already performed 2021-12-10 and one scheduled for 2022-03-18)</p>

**Table 14: Description of Activity 7**

<b>ACTIVITY 8.</b>	<b>Real Time Simulations EXE003</b>
Description	Real Time Simulations - EXE-10.96 ASR-TRL6-VALP-003 (ENAIRES, INDRA, CRIDA)

Related Arguments	
HP OBJECTIVES	W2.PJ10.96-HP-ASR-001 / 002 /003 / 004/ 005/ 006/ 007 / 010/ 011/ 012 / 013/ 014/ 015/ 017/ 018/ 022/ 023
Issues to be addressed / investigated from issues analysis	Arg 1.2.5 Arg 1.3.2 / Arg 1.3.5 / Arg 2.1.4 /Arg 2.1.5 / Arg 2.1.6 Arg 2.2.1 / Arg 2.2.2 Arg 2.3.1 / Arg 2.3.6 Arg 4.5.1 / Arg 4.5.3
Tool selected out of the HP repository	Following tools will be used <ul style="list-style-type: none"> <li>• Workload: NASA-tlx+ Tailor-Made Questionnaires</li> <li>• Situation awareness: SASHA</li> <li>• Acceptability: Tailor-Made Questionnaires</li> <li>• Usability: Tailor-Made Questionnaires</li> <li>• Trust: SATI</li> <li>•</li> </ul>
Required Evidence	Data will be collected mainly via subjective methods (standard and customized questionnaires, observations, and debriefings). Log data will be collected to assess the ASR system performance.
Resources	HP experts, questionnaires, observations, debriefing
Timeline	8-12 November 2021
summary of the hp activity	<ul style="list-style-type: none"> <li>- Preparation of validation schedule;</li> <li>- Platform testing</li> <li>- Preparation of simulation environment and exercises;</li> <li>- Preparation of briefing material;</li> <li>- Preparation of questionnaires (and other data collection);</li> <li>- Execution of experiment;</li> <li>- Data collection and post simulation analysis of the results.</li> </ul>

Table 15: Description of Activity 8

Activity 9.	Real Time Simulations EXE005
Description	Real Time Simulations - EXE-10.96 ASR-TRL6-VALP-005  (SINTEF) in cooperation with EXE-PJ.09-W2-44-V3-VALP-005 (ENAV, SINTEF main participants)
Related Arguments	
HP OBJECTIVES	OBJ-05.971-TRL4-TVALP-001 / 002 / 003 / 004 / 005 / 006 / 012 / 013 / 014 / 015 / 016 / 019 / 021
Issues to be addressed / investigated from issues analysis	ARG1.2. / ARG1.3.2 / ARG1.3.5 / ARG2.1.6 / ARG2.2.1 / ARG2.2.2 / ARG2.3.1 / ARG2.3.4 / ARG2.3.8 / ARG 4.1.2
Tool selected out of the HP repository	<ul style="list-style-type: none"> <li>• Workload: Bedford and Tailor-Made Questionnaires</li> <li>• Situational Awareness: SASHA</li> <li>• Acceptability: Debriefing, Tailor-Made Questionnaires, Interviews</li> <li>• Usability: SUS, Tailor-Made Questionnaires, Interviews</li> <li>• Trust: SATI</li> <li>• Human Error: Tailor-Made Questionnaires, Interviews</li> <li>• Post Run and Post Simulation dedicated questionnaire and debrief procedure, including discussion on SA / acceptability / workload</li> </ul>
Required Evidence	Data will be collected both via subjective methods (standard and customized questionnaires, observations, interviews and debriefings) and through log files.
Resources	Defined in accordance with PMP. Further details in TVALP.
Timeline	September 2022
Planning and Approach	Preparation of validation planning; preparation of RTS platform; operational and technical assessment test of the platform; integration of collected evidence in the RTS platform; preparation of briefing and training material; preparation of the data collection and questionnaires; execution of training;



	execution of the simulation; data collection and post simulation analysis of the results.
summary of the hp activity	

Table 16: Description of Activity 9

ACTIVITY 10.	HP Post-validations F2F workshop
Description	Workshop – integration and consolidation of HP solution results
Related Arguments	
HP OBJECTIVES	Review and integration of HP/SAF solution results, recommendations, requirements and remove potential duplication with safety requirements
Issues to be addressed / investigated from issues analysis	<ul style="list-style-type: none"> <li>• for each exercise, presentation of results</li> <li>• Solution objectives coverage</li> <li>• HP and SAF aspects</li> <li>• Merge and consolidation of conclusions and recommendations</li> </ul>
Tool selected out of the HP repository	
Timeline	Q1 2023
Summary of the hp activity	Consolidation of HP argument and requirements

Table 17: Description of Activity 10

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

### 4.6.1 Summary of HP activities results & recommendations / requirements

Table 19: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

Issue ID	HP Issue ID	HP Issue/ Benefit	HP/ Valid	Associa ted EXE	Identifier evidence	Recommend ations	Requirem ents
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		. Obj. ID		(Success Criteria)		
1.2.5  Operating methods (procedures) can be followed in an accurate, efficient and timely manner.	HFI-ARG1.2.5-10.96_ASR_V2-001	<b>ISSUE:</b> Operating methods can't be followed in accurate, efficient and timely manner.	OBJ-PJ10.W2.S96.ASR TRL6-HPAP-001	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003	Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).  ATCOs stated that the workload did not change or was decreased using the ASR technology.	TSR-PJ10-W2-96 ASR-0060
	1.3.2  Tasks can be achieved in a timely manner.	HFB-ARG1.3.2-10.96_ASR_V2-001	<b>BENEFIT:</b> Potential for human error is reduced with automatic highlight and clearance recognition	OBJ-PJ10.W2.S96.ASR TRL6-HPAP-002	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-	

				TVALR- ASR-005				
HFI- ARG1.3.2- 10.96_ASR _V2-001	<p><b>ISSUE:</b> Wrong recognised ASR command is not realised by ATCO with potential of Human Error increase: ATCO does not realize the wrong command and the wrong command is automatically accepted by the system.</p> <p>Potential of overreliance on the ASR tool support.</p> <p>Consequent decrease of situation awareness and increase in human error.</p> <p><i>This issue also affects argument:</i></p> <p>Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]</p> <p>Arg. 1.3.3: The level of workload (induced by cognitive</p>	OBJ- PJ10. W2 S96 ASR TRL6- HPAP -003	EXE- 10.96- TRL6- TVALR- ASR-001	EXE- 10.96- TRL6- TVALR- ASR-002	EXE- 10.96- TRL6- TVALR- ASR-003	EXE- 10.96- TRL6- TVALR- ASR-005	Potential changes to the end users tasks are achievable within an acceptable time frame (acceptable can be defined based on end users opinion and good HF practice) and accuracy of information should be considered.	RECOM_10- 96-001_4

		and/or physical task demands) is acceptable.				
1.3.5  Human actors can maintain a sufficient level of situation awareness	HFI-ARG1.3.5-10.96_ASR_V2-001	<b>ISSUE:</b> The spare resources as task load is reduced due to support of ASR (no need for manual input) and therefore positive impact on situational awareness.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-004	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	Potential changes to situation awareness and the preliminary mitigation identified are acceptable (acceptable can be defined based on end users opinion and good HF practice relating to situation awareness)  All ATCOs saw their situational awareness as increased or unaffected with the introduction of the ASR system.	
	HFB-ARG1.3.5-10.96_ASR_V2-001	<b>BENEFIT:</b> The tool recognises and displays all key elements of the clearance causing controllers increase in situation	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-005	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-	Potential changes to situation awareness and the preliminary mitigation identified are acceptable	RECOM_10-96-001_7

	awareness and ability to accomplish tasks.		TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	(acceptable can be defined based on end users opinion and good HF practice relating to situation awareness)  All ATCOs saw their situational awareness as increased or unaffected with the introduction of the ASR system.	
HFI-ARG1.3.5-10.96_ASR_V2-00B	<b>ISSUE:</b> The tool doesn't recognise and/or do not display all key elements of the clearance causing controllers decrease in situation awareness and ability to accomplish tasks.	OBJ-PJ10.W2.S96.ASR.TRL6-HPAP-006	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	Potential changes to situation awareness and the preliminary mitigation identified are acceptable (acceptable can be defined based on end users opinion and good HF practice relating to situation awareness)  All ATCOs saw their	RECOM_10-96-001_7

					situational awareness as increased or unaffected with the introduction of the ASR system.		
2.1.1  The task allocation between the human and the machine is consistent with automation principles.	HFI-ARG2.1.1-10.96_ASR_V2-001	<b>ISSUE:</b> The higher degree of automation might lead to deterioration of controllers' (core) skills.	OBJ-PJ10.W2.S96.ASR.TRL6-HPAP-007	Assess whether EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003	Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).		
2.1.2  Changes to the task allocation between human and machine support human performance.	HFB-ARG2.1.2-10.96_ASR_V2-001	<b>BENEFIT:</b> With the higher degree of automation, the ASR tool / functionality assists controllers in their monitoring tasks by freeing up cognitive resources (due to the call-sign highlights function.) This leads to an	OBJ-PJ10.W2.S96.ASR.TRL6-HPAP-008	EXE-10.96-TRL6-TVALR-ASR-001	Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human		

		increase in controller efficiency.			Factors Questionnaire).		
2.1.3  Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the human actors in a timely, efficient and accurate manner	HFI-ARG2.1.3-10.96_ASR_V2-001	<b>ISSUE:</b> The performance of the ATCO is affected by the unusual/degraded scenario in which ASR fails forcing a return to manual.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-009	EXE-10.96-TRL6-TVALR-ASR-001	Task allocation between human and machine, resulting from the introduction of the ASR system support, is rated as good as in baseline (with respect to feedback to Human Factors Questionnaire).	RECOM_10-96-001_5 RECOM_10-96-001_3	
2.1.4  The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	HFB-ARG2.1.4-10.96_ASR_V2-001	<b>BENEFIT:</b> ASR reduces workload suggesting ATCO command based on ATCO-Flight R/T. This might also positively affect ATCO productivity.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-010	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	Level of workload within acceptable limits ('acceptable limits' to be defined with regard to the tool used for the assessment).  ATCOs stated that the workload did not change or was decreased using the ASR		

					technology .	
2.1.5  Human actors can acquire an adequate mental model of the machine and its automated functions.	HFB-ARG2.1.5-10.96_ASR_V2-001	<b>BENEFIT:</b> The establishment of the controller's mental model could be positively affected by the higher degree of automation.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-011	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	The introduction of the ASR system into the context of application is operationally viable, ATCos workload with ASR shall be equal or better than in baseline (without ASR support).  ATCos stated that the workload did not change or was decreased using the ASR technology .	
2.1.6  The level of trust in automated functions is appropriate.	HFI-ARG2.1.6-10.96_ASR_V2-001	<b>ISSUE:</b> General ASR recognition success rate affects controllers trust, therefore the controller does not cross-check the quality of the output due	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-012	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-	The level of trust in the ASR system and its sub-systems and functions is appropriate (potential issues related to trust and preliminary mitigations	RECOM_10-96-001_4



		to over-reliance.		TVALR-ASR-003	are identified).  Answers indicate that although the system was useful and understandable it was not accurate or reliable enough to be confident with the system	
<b>2.2.1</b>  <b>The accuracy of information provided by the system is adequate for carrying out the task.</b>	HFI-ARG2.2.1-10.96_ASR_V2-001	<b>ISSUE:</b> Incorrect highlight of aircraft / incorrect recognition of clearance in situations with a lot of clearances might not be accurate <b>ISSUE:</b> ASR tool failing to recognise combined clearances	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-013	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003	The accuracy of the information provided by the ASR system is adequate for the accomplishment of operations with respect to requirements in TS/IRS (Command Recognition Rate, command Recognition Error Rate).  Controllers considered that the accuracy was not enough to	RECOM_10-96-001_2  RECOM_10-96-001_7

					support them	
<p><b>2.2.2</b></p> <p><b>The timeliness of information provided by the system is adequate for carrying out the task.</b></p>	<p>HFI-ARG2.2.2-10.96_ASR_V2-001</p>	<p><b>ISSUE:</b> The timeliness of the information is not adequate for controllers to carry out their tasks, e.g. calculation results appear with delay, no update in opened interface display.</p>	<p>OBJ-PJ10.W2 S96 ASR TRL6-HPAP -014</p>	<p>EXE-10.96-TRL6-TVALR-ASR-001</p> <p>EXE-10.96-TRL6-TVALR-ASR-002</p> <p>EXE-10.96-TRL6-TVALR-ASR-003</p>	<p>The timeliness of the information provided by the ASR system is adequate for the accomplishment of operations. Controllers' feedback with respect to Human Factors questionnaire is better than for baseline.</p> <p>Controllers considered that the timeliness of the callsign recognition at the beginning of the phrase should be higher. The timeliness of the callsign at the end of the utterance and event recognition was enough although</p>	<p>TSR-PJ10-W2-96 ASR-0060</p>

					could be improved		
2.3.1  The type of information provided satisfies the information requirements of the human.	HFB-ARG2.3.1-10.96_ASR_V2-001	<b>BENEFIT:</b> Increase of SA because the tool recognises and displays all key elements of the clearance.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-015	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003	Changes in the design of the user interface (input devices, visual displays/output devices, alarm& alerts) support ATCOs in carrying out the tasks.  Majority of responses obtained through show that the Human-Machine Interface was adequate and appropriate to execute the simulation activity.	RECOM_10-96-001_8	
2.3.4  Alarms and alerts have been developed according to HF principles.	HFI-ARG2.3.4-10.96_ASR_V2-001	<b>ISSUE:</b> The ASR warning/alert are not designed according to the HF/usability principles leading to an increase of the	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-016	EXE-10.96-TRL6-TVALR-ASR-001	Changes in the design of the user interface (input devices, visual displays/output devices, alarm&	RECOM_10-96-001_5	

[V1: AIR only]		ops complexity.			alerts) support ATCOs in carrying out the tasks.	
2.3.6 The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable .	HFI-ARG2.3.6-10.96_ASR_V2-001	<b>ISSUE:</b> The HMI is ambiguous and ATCOs are unsure whether their input is recognised/accepted by the system.	OBJ-PJ10.W2 S96 ASR TRL6-HPAP-017	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-TVALR-ASR-002  EXE-10.96-TRL6-TVALR-ASR-003  EXE-10.96-TRL6-TVALR-ASR-005	Changes in the design of the user interface (input devices, visual displays/output devices, alarm& alerts) support ATCOs in carrying out the tasks.  Majority of responses obtained through show that the Human-Machine Interface was adequate and appropriate to execute the simulation activity.	RECOM_10-96-001_6
2.3.7 The user interface design reduces human error as far as	HFB-ARG2.3.7-10.96_ASR_V2-001	<b>BENEFIT:</b> Potential for human error is reduced with automatic highlight and clearance recognition	OBJ-PJ10.W2 S96 ASR V2-HPAP-018	EXE-10.96-TRL6-TVALR-ASR-001  EXE-10.96-TRL6-	Changes in the design of the user interface (input devices, visual displays/output	

possible. [V1: AIR only]				TVALR- ASR-002  EXE- 10.96- TRL6- TVALR- ASR-005	devices, alarm& alerts) support ATCOs in carrying out the tasks. ASR does not increase the potential for human error	
<b>2.3.8</b>  The user interface design supports a sufficient level of individual situation awareness .	HFB- ARG2.3.8- 10.96_ASR _V2-001	<b>BENEFIT:</b> ASR increases situation awareness highlighting call-sign based on ATCO-Flight R/T. This might also affects controller productivity	OBJ- PJ10. W2 S96 ASR TRL6- HPAP -019	EXE- 10.96- TRL6- TVALR- ASR-001  EXE- 10.96- TRL6- TVALR- ASR-002	Changes in the design of the user interface (input devices, visual displays/ output devices, alarm& alerts) support ATCOs in carrying out the tasks.	RECOM_10- 96-001_3
<b>4.1.2</b>  The impact of changes on the job satisfaction of affected human actors has been considered .	HFB-ARG 4.1.2- 10.96_ASR _V2-001	<b>BENEFIT:</b> 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	OBJ- PJ10. W2 S96 ASR TRL6- HPAP -021	EXE- 10.96- TRL6- TVALR- ASR-001  EXE- 10.96- TRL6- TVALR- ASR-005	No negative impact with regard to changes in roles and responsibili ties is envisaged or means for mitigating potential negative	RECOM_10- 96-001_1

		recognition systems).			impacts are identified.	
<b>4.5.1</b>  <b>The content of training for each actor group is specified. (V3 only)</b>	HFI-ARG 4.5.1- 10.96_ASR _V2-001	<b>ISSUE:</b> The training needs are not identified.	OBJ- PJ10. W2 S96 ASR TRL6- HPAP -022	EXE- 10.96- TRL6- TVALR- ASR-002  EXE- 10.96- TRL6- TVALR- ASR-003	Training types needed per actor group are identified  Controllers considered a light training was enough for the callsign highlight features	Controllers indicated that callsign highlight
<b>4.5.3</b>  <b>The required types of training (i.e. classroom, simulator, on-the job training) are identified. (TRL6 only)</b>	HFI-ARG 4.5.3- 10.96_ASR _V2-001	<b>ISSUE:</b> The required types of training (i.e. classroom, simulator, on-the job training) are not properly identified	OBJ- PJ10. W2 S96 ASR TRL6- HPAP -023	EXE- 10.96- TRL6- TVALR- ASR-002  EXE- 10.96- TRL6- TVALR- ASR-003	Training types needed per actor group are identified  Only Executive ATCO was analysed. short training included during the yearly refreshment course	

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## 4.6.2 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.

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Maturity checklist for finalising the V1 assessment			
ID	Question	Answer <i>'yes' or 'no'.</i>	Comments <i>Please substantiate your answer.</i>
1	Have relevant arguments for V1 been addressed and appropriately supported?		<i>Refer to relevant sections of the HP table, e.g.</i> <i>-Arguments addressed and associated evidence</i> <i>-Outcomes of the HP activities</i>
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 V1)?		<i>Refer to relevant sections of the HP table, e.g.:</i> <i>- Arguments addressed and associated evidence</i> <i>- Identified HP benefits and issues</i> <i>- Outcomes of HP activities</i>
3	Have potential interactions with related projects/concepts been identified?		<i>Refer to relevant sections of the HP table, e.g.:</i> <i>- List of related projects</i> <i>- Identified HP benefits &amp; issues concerning the interaction with other projects</i> <i>- Outcomes of specific HP activities</i>
4	In case of different options of the proposed solution, are the decisions for selecting specific options for further assessment based on the consideration of HP benefits and issues?		<i>Refer to the relevant sections of the HP table, e.g.:</i> <i>- Identified HP benefits and issues</i> <i>- Outcomes of specific HP activities</i>



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5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?		<p><i>Refer to relevant sections of the HP table:</i></p> <ul style="list-style-type: none"> <li>- <i>Outcomes of HP activities on HP related measures (workload, situational awareness, human error, task efficiency)</i></li> </ul>
6	Have the preliminary proposed solutions been preliminary assessed with expert/end users input?		<p><i>Refer to relevant sections of the HP table:</i></p> <ul style="list-style-type: none"> <li>- <i>Description of HP activities (in particular, validation activities), including details on participants and test conditions/operational scenarios</i></li> </ul>
7	Are the outcomes of the preliminary assessments in V1 based on the solution assessment mature enough to start V2/TRL4?		<p><i>Refer to the conclusion in TVALR and all conclusions in HP deliverable</i></p>
8	Have all relevant SESAR documentation been updated according to the HP activities outcomes (TS/IRS, TVALR)?		<p><i>Compare the HP table and last version of OSED and SPR</i></p>
9	Have the major factors been addressed that can influence the transition feasibility (e.g. changes in automation level)?		<p><i>Refer to relevant sections of the HP table, e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>Arguments on task allocation human-machine, on impacts on the organisational level</i></li> <li>- <i>Requirements and recommendations for concept implementation</i></li> </ul>
10	Has the next V-phase sufficiently been prepared (open HP issues to be addressed)?		<p><i>Refer to relevant sections of the HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>List of open issues/benefits and associated validation objectives not yet validated;</i></li> <li>- <i>Recommendation for further research.</i></li> </ul>

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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?		<p><i>Refer to relevant sections of the HP table or HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li><i>-Arguments addressed and associated evidence</i></li> <li><i>-Outcomes of the HP activities</i></li> </ul>
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)?		<p><i>Refer to relevant sections of the HP table or HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li><i>- Arguments addressed and associated evidence</i></li> <li><i>- Identified HP benefits and issues</i></li> <li><i>- Outcomes of HP activities (including validation exercises)</i></li> </ul>
3	Have potential interactions with related projects/concepts started to be considered?		<p><i>Refer to relevant sections of the HP table or HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li><i>- List of related projects</i></li> <li><i>- Identified HP benefits &amp; issues concerning the interaction with other projects</i></li> <li><i>- Outcomes of specific HP activities</i></li> </ul>
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?		<p><i>Refer to the relevant sections of the HP table or HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li><i>- Identified HP benefits and issues</i></li> <li><i>- Outcomes of specific HP activities</i></li> </ul>

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5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?		<p><i>Refer to relevant sections of the HP table or HP assessment report:</i></p> <ul style="list-style-type: none"> <li>- <i>Outcomes of HP activities on HP related measures (workload, situational awareness, human error, task efficiency)</i></li> </ul>
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?		<p><i>Refer to relevant sections of the HP table or HP assessment report:</i></p> <ul style="list-style-type: none"> <li>• <i>Arguments addressed and associated actual evidence</i></li> </ul>
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?		<p><i>Refer to relevant sections of the HP table or HP assessment report:</i></p> <ul style="list-style-type: none"> <li>- <i>Description of HP activities (in particular, validation activities), including details on participants and test conditions/operational scenarios</i></li> </ul>
8	Are the outcomes based on the solution assessment mature enough to start V3/TRL6?		<p><i>Refer to the conclusion in TVALR and all conclusions in HP deliverable</i></p>
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?		<p><i>Compare the HP table and last version of OSED and SPR</i></p>
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?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>Arguments on task allocation human-machine, on impacts on the organisational level</i></li> <li>- <i>Requirements and recommendations for concept implementation</i></li> </ul>
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.		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>Arguments on roles &amp; responsibilities, task allocation human-machine, impediments to implementation</i></li> </ul>
12	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?		<p><i>Refer to relevant sections of the HP assessment report, e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>List of open issues/benefits and associated validation objectives not yet validated;</i></li> <li>- <i>Recommendation for further research.</i></li> </ul>

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Maturity checklist for finalising the V3/TRL6 assessment			
ID	Question	Answer <i>Fill in 'yes' or 'no'.</i>	Comments <i>Please substantiate your answer.</i>
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?		<p><i>Refer to relevant sections of the HP table or HP assessment report, e.g.</i></p> <ul style="list-style-type: none"> <li><i>-Arguments addressed and associated evidence</i></li> <li><i>-Outcomes of the HP activities</i></li> </ul>
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3/TRL6)?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li><i>- Arguments addressed and associated evidence</i></li> <li><i>- Identified HP benefits and issues</i></li> <li><i>- Outcomes of HP activities (including validation exercises)</i></li> </ul>
3	Have all the parts of the solution/concept been considered?		<p><i>Refer to the relevant sections of the TVALP, TS/IRS and of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li><i>- Description of the solution/concept and related assumption</i></li> <li><i>- List of assumption that have a link with the HP issue/benefits</i></li> <li><i>- List of issues/benefits and associated validation objectives</i></li> </ul>

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4	Have potential interactions with related projects/concepts been considered and addressed?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>List of related projects</i></li> <li>- <i>Identified HP benefits &amp; issues concerning the interaction with other projects</i></li> <li>- <i>Outcomes of specific HP activities</i></li> </ul>
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>Outcomes of HP activities on HP related measures (workload, situational awareness, human error, task efficiency)</i></li> </ul>
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?		<p><i>Refer to relevant sections of the HP table or HP assessment report:</i></p> <ul style="list-style-type: none"> <li>- <i>Arguments addressed and associated actual evidence</i></li> </ul>
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- <i>Description of HP activities (in particular, validation activities), including details on participants and test conditions/operational scenarios</i></li> </ul>
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?		<p><i>Refer to relevant sections of the HP table or HP assessment report:</i></p> <ul style="list-style-type: none"> <li>- <i>Arguments addressed and associated actual evidence</i></li> <li>- <i>Outcomes of the validation exercises</i></li> </ul>
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?		<p><i>Compare the HP table and last version of OSED and SPR</i></p>

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10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- Arguments addressed and associated evidence</li> <li>- Identified HP benefits and issues</li> <li>- Outcomes of HP activities (including validation exercises)</li> </ul>
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- Outcomes of HP activities (including validation exercises)</li> </ul>
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- Arguments on task allocation human-machine, on impacts on the organisational level</li> <li>- Requirements and recommendations for concept implementation</li> </ul>
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- Arguments on roles &amp; responsibilities, task allocation human-machine, impediments to implementation</li> </ul>
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?		<p><i>Refer to relevant sections of the HP table or HP assessment report e.g.:</i></p> <ul style="list-style-type: none"> <li>- List of open issues/benefits and associated validation objectives not yet validated;</li> <li>- Recommendation for further research.</li> </ul>

## 5 References

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### Human Performance

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- [1] SESAR Human Performance Guidance Reference Material
- [2] 16.06.05 D 27 HP Reference Material D27

### Reference Documents

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- [3] D2.6 PJ19 Validation Strategy VALS (2019)
- [4] D4.1.020 PJ.10-W2-96 ASR TRL6 Final TS/IRS Part I
- [5] D4.1.020 PJ.10-W2-96 ASR TRL6 TS/IRS - Part II

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## Appendix A – Additional HP activities conducted





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## Appendix B HP Recommendations Register

Reference	Type	Recommendation	Rationale	Assessment source + Reference report	Scope ( Air, Air/Ground, Ground)	Solution involved	Recommendation status	Rationale in case of rejection	Comments
RECOM_10-96-001_1	System design	Alternative ways of activation of ASR function for CPDLC usage and HMI navigation (DAC use cases) should be investigated.	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. Also, during the simulation, two different keys on te 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.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		



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<b>RECOM_10-96-001_2</b>	System design	It should be further investigated how partial recognition should be displayed in HMI and at the transcription window.	Although the partial recognition of the tool is useful for ATCOs for identifying callsigns, in the case of flight level or heading instructions, it could send incorrect or undesired information to aircraft, which could impact safety.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		
<b>RECOM_10-96-001_3</b>	System design	It should be investigated into the ASR recognition of pilots' utterances.	Extend the ASR to Pilot side could provide a sort of additional safety net to mitigate the risk of potential mismatches/ misunderstandings ground-air	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		
<b>RECOM_10-96-001_4</b>	System design	The previous output of ASR by existing assistent systems should be continuously monitored (to detect undetected	ATCOs expressed concern about non existing quality control of their errors and system errors – (can also improve safety)	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		



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		errors of the speech recogniser).							
<b>RECOM_10-96-001_5</b>	System design	An alert/ alarm should be implemented in case of ASR malfunction	ATCOs expressed the need to have an alarm which alerts them that ASR is not working properly.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		
<b>RECOM_10-96-001_6</b>	System design	An 'ASR-Diagnostic window' should be implemented which would display useful information, always in the same place, similar to a chat window.	It would display useful information such as history of commands issued, ASR issues etc.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		
<b>RECOM_10-96-001_7</b>	System design	Should enrich the type and number of ATC commands.	ASR could automatically recognise and execute commands such as Assuming or transferring a/c. Also foresee a wider ASR recognised phraseology and more complex commands and instructions.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		
<b>RECOM_10-96-001_8</b>	System design	HMI of the ASR should be coherent	The light gray colour of the 'pop-up' window are	Real Time simulation / Post	Air/Ground	PJ10.96ASR	Open		



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		with the rest of the CWP HMI	not visible enough for the ATCOs, especially if the HMI display colour is similar. Controllers to look for the window, partly because of its colour coding, partly because it would not appear consistently in the same place, but in the last place where the mouse cursor was left.	simulation workshop					
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**Table 18: PJ.10-W2-96 HP Recommendations**

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## Appendix C – HP Requirements Register

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	Requirements	Rationale	Assessment source + Reference report	Scope ( Air, Air/Ground, Ground)	Solution involved	Requirements status	Rationale in case of rejection	Comments
TSR-PJ10-W2-96 ASR-0060	Performance	Shall reduce the latency of the tool.	Feedback from controllers reported that the implementation of ASR in Enroute scenario was affected by latency. Improving ASR’s latency could better support controllers in maintaining an acceptable levels of trust, acceptability, perceived safety.	Real Time simulation / Post simulation workshop	Air/Ground	PJ10.96ASR	Open		

Table 21: HP Requirements



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## Appendix D – HP Log



HP log 1.xlsx



HP log 2.xlsx



HP log 3.xlsx



HP log 4.xlsx



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## PJ10-W2-96 BENEFICIARY'S LOGOS



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