

# SESAR 2020 Solution PJ.02-W2-21.1 SPR- INTEROP/OSED for V3 - Part IV - Human Performance Assessment Report

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# AART

## AIRPORT AIRSIDE AND RUNWAY THROUGHPUT

This **PJ.02-W2-21.1 Human Performance Assessment Report** is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874477 under European Union's Horizon 2020 research and innovation programme.



### Abstract

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This document contains the Human Performance (HP) assessment report for **Solution PJ02-W2-21.1 Extended Airport Safety Nets for Controllers** at A-SMGCS 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 Step 4 – Collate findings & conclude on transition to next V-phase.

This report consolidates the results of the different HP activities conducted by means of documents review and validation exercises:

- Stakeholder's workshop
- Prototyping sessions
- Validation Exercises (Questionnaires & debriefing sessions) :
  - Real-time simulations
  - Live trials exercises

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# 1 Executive Summary

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The Solution **PJ02-W2-21.1 Extended Airport Safety Nets for Controllers at A-SMGCS** aims at enhanced Safety for airport operations. Safety Support Tools for controllers at A-SMGCS Airports detect potential and actual conflicting situations, incursions and non-conformance to procedures or ATC clearances, involving mobiles (and stationary traffic) on runways, taxiways and in the apron/stand/gate area as well as unauthorised/unidentified traffic. Controllers are provided in all cases with the appropriate alerts.

This document contains the Human Performance assessment report (HPAR) for **Solution PJ02-W2-21.1** 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 Step 4 – Collate findings & conclude on transition to next V-phase.

This report consolidates the results of the different HP activities conducted by means of documents review and validation exercises:

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  - Real-time simulations
  - Shadow modes exercises

An overall of 11 issues and 14 benefits (see section 4.4.1) were identified initially after identifying the nature of the change due to the introduction of the concept. All these issues and benefits were translated to Human Performance objectives and correctly evaluated in the validation activities. As result all the benefits and issues have been closed.

Finally, 4 recommendations and 6 requirements were identified as a consequence of the assessment of the identified issues and benefits. These recommendations and requirements are included in the Final OSED of the solution.

## 2 Introduction

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### 2.1 Purpose of the document

The purpose of this document is to describe the result of the activities conducted according to the Human Performance (HP) assessment process [2] in order to derive the HP assessment report for Solution PJ02-W2-21.1 **Extended Airport Safety Nets for Controllers at A-SMGCS Airports** including requirements and recommendations.

### 2.2 Intended readership

The intended audience for this document are:

- **PJ.02-W2-21.1** members, including Solution Managers, Concept Design Experts, Human Performance Assessment Experts, Safety Experts, Validation Experts and Technical Experts.
- **PJ.02-W2-AART**- consistency with PJ.02-W2 solutions and alignment with ATM Master Plan managed by PJ.02-W2 PCIT.
- **PJ19-04** -Specially HP experts that will assess the deliverable.
- **Post SESAR 2020 Wave 2** - Future audience involved in industrialisation (V4) and deployment activities (V5).
- ANS providers as interested in new developments that will enhance the safety of the airport operations.



## 2.3 Structure of the document

This document is structured into the following chapters:

- Chapter 1 is the executive summary and contains the key information of the Human Performance Assessment Report.
- Chapter 2 is the introduction and describes the purpose of the document, the intended readership, the scope of the document, the structure of the document, and the acronyms and terminology used through it.
- Chapter 3 details the Human Performance Assessment Process followed.
- Chapter 4 constitutes the core of the document and includes the Human Performance implications, the description of the Human Performance activities conducted and the consolidation of the Human Performance results, recommendations, requirements. It also includes the maturity assessment of Solution PJ02-W2-21.1 from the Human Performance perspective.
- Chapter 5 contains the list of references used in the document.
- Appendix A describes the additional Human Performance activities conducted.
- Appendix B constitutes the Human Performance Recommendations Register.
- Appendix C constitutes the Requirements Register.

## 2.4 Acronyms and Terminology

Term	Description
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATCO	Air Traffic Control Operator (i.e., the Controller)
ATM	Air Traffic Management
CATC	Conflicting ATC Clearances
CMAC	Conformance Monitoring Alerts for Controllers
CRSS	Cross
EXE	Validation exercise
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.
LND	Landing
TOF	Take Off

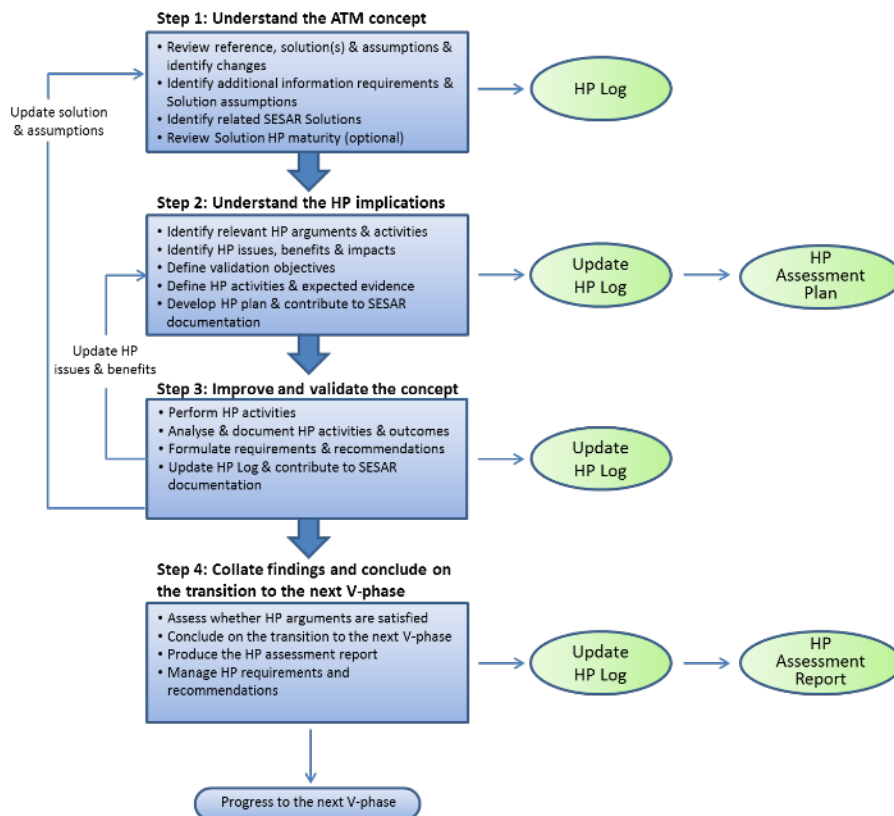
**Table 1: Acronyms and terminology**

### 3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP assessment process described in detail in Human Performance Guidance material [3] 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. 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.

The HP assessment process is a four-step process. [2] provides an overview of these four steps with the tasks to be carried out and the two main outputs (i.e. HP plan and HP assessment report). In addition, a 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 updated and / or added to as the SESAR Solution progresses.



Steps of the HP assessment process

## 4 Human Performance Assessment

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### 4.1 Step 1 Understand the ATM concept

#### 4.1.1 Description of reference scenario

Please refer to PJ.02-W2-21.1 Validation Plan (VALP) for V3 - Part I, Section 4.1.1 Reference Scenario [7].

#### 4.1.2 Description of solution scenario

Please refer to PJ.02-W2-21.1 Validation Plan (VALP) for V3 - Part I, Section 4.1.1 Solution Scenario and Sections 5.x.4 [7]

#### 4.1.3 Consolidated list of assumptions

Please refer to PJ.02-W2-21.1 Validation Plan (VALP) for V3 - Part I, Section 4.4 Validation Assumptions and the exercise-specific Validation Assumption in Sections 5.x.5 [7]

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

##### SESAR 1

SESAR 1 Solution #02 **Airport Safety Nets for controllers: conformance monitoring alerts and detection of conflicting ATC clearances** and SESAR 1 Solution #22 **Automated Assistance to Controller for Surface Movement Planning and Routing** have been identified as relevant solutions since both are prerequisite to the deployment of AO-0104-B.

Solution #02 is extended by the present Solution PJ.02-W2-21.1.

Solution #22 is the routing and planning function of the A-SMGCS which provides the routes necessary to detect the non-conformances covered by the updated CMAC alerts.

##### SESAR 2020

The CATC and CMAC alerting functions defined in the scope of SESAR 1 Solution #02 have been updated and expanded in SESAR 2020 Wave 1 Solution PJ03b-01 (V2) to cover the entire airport surface.

The present solution PJ.02-W2-21.1 continues the previous work by PJ03b-01 to achieve V3, except the validation of the NO TAXI (FtG) which is validated in PJ.02-W2-21.4.

#### 4.1.5 Identification of the nature of the change

The change assessment is used to systematically identify and record the nature of the change that may result from the introduction of the concept under study in relation to the ATM actors concerned and the possible changes in their work.

The HP argument branches of the table cover the second level of HP arguments in Appendix A of [2] and so is not only used to help identify and capture changes in terms of ATM actors and their corresponding work but can also be used to help screen and scope the HP assessment. Therefore, the table helps to narrow down and focus the list of HP arguments that need to be investigated in the next step of the HP assessment. Furthermore, if there are no changes identified that relate to any of the HP argument branches in the table then no HP assessment is required on the Solution.

The changes addressed in concern the CATC and CMAC services defined and validated in Solution #02.

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES Left column	
1.1 ROLES & RESPONSIBILITIES	No changes in Roles and Responsibilities are foreseen.
1.2 OPERATING METHODS	No changes in operating methods are expected.
1.3 TASKS	<b>Yes</b> - The main change to controller tasks concerns the management of new and extended alerts on the HMI (the management of the corresponding conflicts is not expected to change). However, there are no changes in working procedures associated with the new alerts.
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	<b>Yes</b> - The detection of conflicts in the solution is performed in parallel by the machine, as it is by the controller. This is the main re-allocation of man-machine tasks.
2.2 PERFORMANCE OF TECHNICAL SYSTEM	<b>Yes</b> - Technical systems incorporate alert algorithms in the solution, able to: <ul style="list-style-type: none"> <li>• Extrapolate the behaviour of aircraft, and</li> <li>• Customise triggering and termination conditions to reduce nuisances and false alerts.</li> <li>• Customise the priority of alerts to support the local procedures.</li> </ul> <p>The timeliness of the new alerts provided by the system needs to be adequate for triggering the controller’s task to manage the corresponding conflict.</p>
2.3 HUMAN – MACHINE INTERFACE	<b>Yes</b> - The colour-coding, alert-naming, alert label look and feel, predictive indication usability for new and extended alerts in the solution HMI have evolved to provide a global

	visual coherence and perceived prioritisation. Input devices have not changed.
<b>3. TEAMS &amp; COMMUNICATION</b>	
3.1 TEAM COMPOSITION	No changes in Team Composition.
3.2 ALLOCATION OF TASKS	No changes in Allocation of Tasks.
3.3 COMMUNICATION	No changes in Communication are expected, however the level of shared situational awareness of the team should increase (the controllers will be aware of the critical situations in the AOR of other controller)
<b>4. HP RELATED TRANSITION FACTORS</b>	
4.1 ACCEPTANCE & JOB SATISFACTION	<b>Yes</b> - If the system is usable and the automation support provided leads to the expected reduction in mental workload and an improvement in situational awareness, this should have a positive impact on acceptability of the system and procedures and the job satisfaction.
4.2 COMPETENCE REQUIREMENTS	<b>No</b> changes.
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	<b>No</b> changes.
4.4. RECRUITMENT AND SELECTION	<b>No</b> changes.
4.5. TRAINING NEEDS	<b>Yes</b> – to be assessed in the HP activities

**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

This section lists the HP arguments that have been identified as relevant for Solution PJ.02-W2-21.1 (see “Issue-Objective-Outcome” tab in the HP Log in Appendix A). It also describes the HP solution-specific issues and benefits identified with an HP argument.

The “Issue-Objective-Outcome” tab from the HP Log (see Appendix A) is used for this stage as it allows the HP experts to update the status of the issues/ benefits as soon as validation activities are carried out. As a result, the bridge with the HP Assessment Report can already be done in the HP Log which is a working document that evolves from A Plan to a Report. The HP Log contains a more detailed list of the identified HP argument, issues and benefits, along with their impacts on Human Performance and the KPAs.

Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	recommended activity/ies
2.3.1	2.3.1-21.1-015-HP	Issue: The controller is not able to take action based on the information given by the new alerts, because the information is incomplete or unclear.	OBJ-02.21.1-V3-VALP-001	To evaluate if the HMI is suitable for the controller to assess the new alerts	Real Time Simulation Shadow-Mode Trial
2.3.1	2.3.1-21.1-016-HP	Benefit: The information provided by the new alerts gives the controller the information required to solve the problem.	"	"	"
2.3.8	2.3.8-21.1-020-HP	Benefit: Identification of mobiles involved in the conflicting situation indicated by the alert is easily recognizable.	"	"	"
2.3.8	2.3.8-21.1-021-HP	Benefit: Information displayed by the alerting HMI is in agreement with information displayed by other user interfaces of the CWP.	"	"	"
2.3.8	2.3.8-21.1-022-HP	Benefit: The alerts displayed are consistent with the traffic development.	"	"	"



1.3.5	1.3.5- 21.1- 007-HP	Benefit: The controller uses the CATC Predictive Indication to update his/her awareness for possible critical situations caused by conflicting clearances.	OBJ-02.21.1-V3- VALP-003	To assess the utility of the CATC predictive indication in combination with the new CATC Alerts	Real Time Simulation Shadow-Mode Trial
2.3.8	2.3.8- 21.1- 023-HP	Benefit: CATC Predictive Indication gives a reliable prediction of the impact of the next clearance to be given to a mobile.	"	"	"
2.3.6	2.3.6- 21.1- 018-HP	Issue: The usability of the CATC Predictive Indication is not acceptable.	OBJ-02.21.1-V3- VALP-004	To assess the usability of the CATC predictive indication in combination with the new CATC Alerts.	Real Time Simulation Shadow-Mode Trial
1.3.5	1.3.5- 21.1- 008-HP	Benefit: The use of the CMAC STAND OCCUPIED alert for informing the controller when a stand is currently occupied might lead to a potential increase in human operator's situational awareness	OBJ-02.21.1-V3- VALP-301	To assess the utility of the CMAC alert - Stand Occupied	Real Time Simulation
1.2.3	1.2.3- 21.1- 002-HP	Issue: The controller might use the CATC Predictive Indication to update his situational awareness. The controller needs to know if he can rely upon the indication.	OBJ-02.21.1-V3- VALP-HP-001	To assess the impact of the new and updated Safety Support Tools on the Human Performance	Real Time Simulation Shadow-Mode Trial

1.3.1	1.3.1- 21.1- 003-HP	Issue: In case the new alerts generate too many nuisance alerts this might lead to misunderstandings of the human operator and to mistakes based on the alerts displayed. In addition, the nuisance alerts might distract the human operator from his/her current tasks, leading to a potential increase in human errors.	"	"	"
1.3.1	1.3.1- 21.1- 004-HP	Benefit: Controller decisions are less prone to errors by using CATC Predictive Indication.	"	"	"
1.3.3	1.3.3- 21.1- 005-HP	Issue: The new alerts displayed in the HMI might increase the level of attention and cognitive demand for the human operator, as potentially a higher number of alerts will need to be assessed.	"	"	"
1.3.3	1.3.3- 21.1- 006-HP	Benefit: The new CATC alert informs the controller early on of the potential conflict that is to be resolved and gives additional time to solve the situation.	"	"	"
2.3.7	2.3.7- 21.1- 019-HP	Benefit: The User Interface design clearly visualises the alerting information.	"	"	"

2.1.5	2.1.5-21.1-009-HP	Issue: The controller does not understand the rules and conditions that trigger the new CMAC alerts. Consequently, s/he is not able to correctly assess the situation and the conflicting clearances.	OBJ-02.21.1-V3-VALP-HP-002	To assess the ATCOs understanding of the conditions triggering the new and updated alerts.	Real Time Simulation Shadow-Mode Trial
2.1.5	2.1.5-21.1-010-HP	Issue: The controller does not understand the rules and conditions that trigger the new/updated CATC alerts. Consequently, s/he is not able to correctly assess the situation and the conflicting clearances.	"	"	"
2.1.6	2.1.6-21.1-011-HP	Benefit: The controller trusts the new alerts and prediction indications provided by the Safety Support Tools. S/he considers the information provided and accepts the system support to monitor the traffic development.	OBJ-02.21.1-V3-VALP-HP-003	To assess the ATCOs level of trust in the automated function triggering the new and updated alerts.	Real Time Simulation Shadow-Mode Trial
2.1.6	2.1.6-21.1-012-HP	Issue: The controller has a too high degree of trust in the new Safety Support Tools and relies on the system to trigger an alert in case the controllers attention is required. As a result the controller neglects his/her task to monitor the traffic.	"	"	"

2.2.1	2.2.1-21.1-013-HP	Benefit: The information given in the new alerts is complete and accurate. This enables the controller to manage the conflict situation.	OBJ-02.21.1-V3-VALP-HP-004	To assess that the updated and new alerts are satisfying the needs to support the controller	Real Time Simulation Shadow-Mode Trial
2.2.1	2.2.1-21.1-014-HP	Benefit: The controller receives the alert in time to use the information provided to manage the conflict situation.	"	"	"
3.3.5	3.3.5-21.1-024-HP	Benefit: Controllers are aware of the critical situations taking place in the AoR of other controllers.	OBJ-02.21.1-V3-VALP-HP-005	To validate that ATCOs are aware of the critical situations taking place in the AoR of other controllers.	Real Time Simulation Shadow-Mode Trial
4.1.2	4.1.2-21.1-0265-HP	Benefit: If the new alerts are proven to be accurate, complete and usable (timeliness), their operation will not lead to a reduced job satisfaction perceived by the human operator.	OBJ-02.21.1-V3-VALP-HP-006	To assess the ATCOs expectations regarding the impact of the new/updated safety nets on their job satisfaction.	Real Time Simulation Shadow-Mode Trial
4.5	4.5-21.1-026-HP	Issue: The information that needs to be conveyed to the controller in the training on the new alerts has to be specified. The adequate training enables the controller to recognise the alert, perceive the information provided and to decide what actions need to be executed.	OBJ-02.21.1-V3-VALP-HP-007	To collect the training needs required to prepare the ATCOs for the operation of the new/updated safety nets.	Real Time Simulation Shadow-Mode Trial

4.5.3	4.5.3- 21.1- 027-HP	Issue: The “Type of training” (e.g. classroom, simulator, on-the-job training) needs to be identified to provide an comprehensive training on all aspects of the new alerts. (trade the pros and cons of the different settings and identify what needs compensation if it cannot be provided in a specific setting).	"	"	Workshop
2.3.4	2.3.4- 21.1- 017-HP	Issue: The colour-coding, alert-naming, and alert label look and feel might lack a global visual coherence, what causes the controller to lose track of the situation indicated by the new alerts.	OBJ-02.21.1-V3- VALP-HP-008	To assess that the HMI design supports the viewer in recognizing the displayed safety-critical situations	Real Time Simulation Shadow-Mode Trial

Table 3: HP Arguments, related HP issues and benefits, and proposed HP activity

## 4.3 Step 3 Improve and validate the concept

### 4.3.1 Description of HP activities conducted

This section forms the actual HP activity plan. It contains the HP activities that were selected based on the relevant arguments and HP Issues & Benefits. The following Table provides an overview of the HP activities and deadlines:

HP activity	By when
Activity 1: Workshop Series	April - October 2021
Activity 2: Shadow-Mode Trial	October 2021
Activity 3: Real-Time Simulation	7-18 March 2022
Activity 4: Real-Time Simulation	October 2022

**Table 4: Human Performance Activities conducted in PJ02-W2-21.1**

Activity 1.	Workshop Series
Description	The workshop series for the preparation of validation exercise EXE 1, conducted by <b>DFS</b> , carries out a long-term analysis of recorded EDDL traffic development (see VALP part I [7], section 5.1.7.3.1). The goal is to iteratively improve the CATC alerts in order to optimize their acceptance by the ATCOs. The workshops are used to examine the controller opinions, knowledge, perceptions, expectations, and concerns about the new and enhanced CATC alerts introduced by Solution PJ.02-W2-21.1. Getting feedback from controllers on their user experience and iteratively improving the solution accordingly is key to a successful validation exercise.
Arguments & related issues addressed	<b>ARG 2.3.1</b> (2.3.1- 21.1-015-HP; 2.3.1- 21.1-016-HP) <b>ARG 2.3.8</b> (2.3.8-21.1-020-HP; 2.3.8-21.1-021-HP; 2.3.8-21.1-022-HP) <b>ARG 2.1.5</b> (2.1.5- 21.1-009-HP) <b>ARG 2.1.6</b> (2.1.6- 21.1-011-HP; 2.1.6- 21.1-012-HP) <b>ARG 2.2.1</b> (2.2.1- 21.1-013-HP; 2.2.1- 21.1-014-HP) <b>ARG 4.1.2</b> (2.2.1- 21.1-025-HP)
HP objectives	<b>OBJ-02.21.1-V3-VALP-001.</b> To evaluate if the HMI is suitable for the controller to assess the new alerts.  <b>OBJ-02.21.1-V3-VALP-HP-002.</b> To assess the ATCOs understanding of the conditions triggering the new and updated alerts

	<p><b>OBJ-02.21.1-V3-VALP-HP-003.</b> To assess the ATCOs level of trust in the automated function triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-004.</b> To assess that the updated and new alerts are satisfying the needs to support the controller</p> <p><b>OBJ-02.21.1-V3-VALP-HP-006.</b> To assess the ATCOs expectations regarding the impact of the new/updated safety nets on their job satisfaction</p>
Tools / Methods selected out of the HP repository	Video presentations (recorded traffic situations and triggered alerts) Prepared questionnaires Interviews
Summary of the HP activity	Workshop as preparatory activity (before the shadow mode)

**Table 5: Description of Activity 1**

<b>ACTIVITY 2.</b>	<b>Shadow-Mode Trial</b>
Description	Validation Exercise <b>PJ.02-21 Val EXE 1 "V3</b> Validation of Extended Airport Safety Nets for Controllers at Düsseldorf Airport", conducted by <b>DFS</b> , validates the extended and updated <b>CATC Alerts for Runway Operations</b> and <b>CATC Alerts for Ground Operations</b> (see VALP part I [7], section 5.1 and Appendix B).
Related Arguments	<p><b>ARG 2.3.1</b> (2.3.1- 21.1-015-HP; 2.3.1- 21.1-016-HP)</p> <p><b>ARG 2.3.8</b> (2.3.8-21.1-020-HP; 2.3.8-21.1-021-HP; 2.3.8-21.1-022-HP; 2.3.8-21.1-023-HP)</p> <p><b>ARG 1.3.5</b> (1.3.5- 21.1-007-HP)</p> <p><b>ARG 2.3.6</b> (2.3.6- 21.1-018-HP)</p> <p><b>ARG 1.2.3</b> (1.2.3- 21.1-002-HP)</p> <p><b>ARG 1.3.1</b> (1.3.1- 21.1-004-HP; 1.3.1- 21.1-003-HP))</p> <p><b>ARG 1.3.3</b> (1.3.3- 21.1-005-HP; 1.3.3- 21.1-006-HP)</p> <p><b>ARG 2.3.7</b> (2.3.7- 21.1-019-HP)</p> <p><b>ARG 2.1.5</b> (2.1.5- 21.1-009-HP)</p> <p><b>ARG 2.1.6</b> (2.1.6- 21.1-011-HP; 2.1.6- 21.1-012-HP)</p> <p><b>ARG 2.2.1</b> (2.2.1- 21.1-013-HP; 2.2.1- 21.1-014-HP)</p> <p><b>ARG 4.1.2</b> (2.2.1- 21.1-025-HP)</p> <p><b>ARG 4.5</b> (4.5-21.1-026-HP)</p> <p><b>ARG 4.5.3</b> (4.5.3-21.1-027-HP)</p>
HP objectives	<b>OBJ-02.21.1-V3-VALP-001.</b> To evaluate if the HMI is suitable for the controller to assess the new alerts.

	<p><b>OBJ-02.21.1-V3-VALP-003.</b> To assess the utility of the CATC predictive indication in combination with the new CATC Alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-004.</b> To assess the usability of the CATC predictive indication in combination with the new CATC Alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-001.</b> To assess the impact of the new and updated Safety Support Tools on the Human Performance.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-002</b> To assess the ATCOs understanding of the conditions triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-003.</b> To assess the ATCOs level of trust in the automated function triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-004.</b> To assess that the updated and new alerts are satisfying the needs to support the controller.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-006.</b> To assess the ATCOs expectations regarding the impact of the new/updated safety nets on their job satisfaction.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-007.</b> To collect the training needs required to prepare the ATCOs for the operation of the new/updated safety nets.</p>
<p>Issues to be addressed / investigated from issues analysis</p>	<p>2.3.1- 21.1-015-HP                  2.3.1- 21.1-016-HP                  2.3.8-21.1-020-HP                  ; 2.3.8-21.1-021-HP                  2.3.8-21.1-022-HP                  2.3.8-21.1-023-HP                  1.3.5- 21.1-007-HP                  2.3.6- 21.1-018-HP                  1.2.3- 21.1-002-HP                  1.3.1- 21.1-004-HP                  1.3.1- 21.1-003-HP                  1.3.3- 21.1-005-HP                  1.3.3- 21.1-006-HP                  2.3.7- 21.1-019-HP                  2.1.5- 21.1-009-HP                  2.1.6- 21.1-011-HP                  2.1.6- 21.1-012-HP                  2.2.1- 21.1-013-HP                  2.2.1- 21.1-014-HP</p>



	2.2.1- 21.1-025-HP 4.5-21.1-026-HP 4.5.3-21.1-027-HP
Tools/Methods selected out of the HP repository	Workload - NASA TLX Situational Awareness - SASHA
summary of the HP activity	Validation Exercise carried out by DFS. Shadow mode at Düsseldorf Airport

**Table 6: Description of Activity 2**

<b>ACTIVITY 3.</b>	<b>Real Time Simulation</b>
Description	Validation Exercise <b>PJ.02-21 Val EXE 3</b> "Real Time Simulation of Extended SMGCS Safety Nets (V3)", conducted by <b>ENAIRE</b> , is running Real-Time Simulations to validate the new and enhanced alerts introduced by Solution PJ.02-W2-21.1 (see VALP part I [7], section 5.2 and Appendix B).
Related Arguments	<p><b>ARG 2.3.1</b> (2.3.1- 21.1-015-HP; 2.3.1- 21.1-016-HP)</p> <p><b>ARG 2.3.8</b> (2.3.8-21.1-020-HP; 2.3.8-21.1-021-HP; 2.3.8-21.1-022-HP; 2.3.8-21.1-023-HP)</p> <p><b>ARG 1.3.5</b> (1.3.5- 21.1-007-HP; 1.3.5- 21.1-008-HP)</p> <p><b>ARG 2.3.6</b> (2.3.6- 21.1-018-HP)</p> <p><b>ARG 1.2.3</b> (1.2.3- 21.1-002-HP)</p> <p><b>ARG 1.3.1</b> (1.3.1- 21.1-004-HP; 1.3.1- 21.1-003-HP))</p> <p><b>ARG 1.3.3</b> (1.3.3- 21.1-005-HP; 1.3.3- 21.1-006-HP)</p> <p><b>ARG 2.3.7</b> (2.3.7- 21.1-019-HP)</p> <p><b>ARG 2.1.5</b> (2.1.5- 21.1-009-HP)</p> <p><b>ARG 2.1.6</b> (2.1.6- 21.1-011-HP; 2.1.6- 21.1-012-HP)</p> <p><b>ARG 2.2.1</b> (2.2.1- 21.1-013-HP; 2.2.1- 21.1-014-HP)</p> <p><b>ARG 3.3.5</b> (3.3.5- 21.1-024-HP)</p> <p><b>ARG 4.1.2</b> (2.2.1- 21.1-025-HP)</p> <p><b>ARG 4.5</b> (4.5-21.1-026-HP)</p> <p><b>ARG 4.5.3</b> (4.5.3-21.1-027-HP)</p> <p><b>ARG 2.3.4</b> (2.3.3-21.1-017-HP)</p>
HP objectives	<p><b>OBJ-02.21.1-V3-VALP-001.</b> To evaluate if the HMI is suitable for the controller to assess the new alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-003</b> To assess the utility of the CATC predictive indication in combination with the new CATC Alerts.</p>

	<p><b>OBJ-02.21.1-V3-VALP-004.</b> To assess the usability of the CATC predictive indication in combination with the new CATC Alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-302.</b> To assess the usability of the CMAC alert - Stand Occupied.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-002.</b> To assess the ATCOs understanding of the conditions triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-003.</b> To assess the ATCOs level of trust in the automated function triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-005.</b> To validate that ATCOs are aware of the critical situations taking place in the AoR of other controllers.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-007.</b> To collect the training needs required to prepare the ATCOs for the operation of the new/updated safety nets</p> <p><b>OBJ-02.21.1-V3-VALP-HP-008.</b> To assess that the HMI design supports the viewer in recognizing the displayed safety-critical situations.</p>
<p>Issues to be addressed / investigated from issues analysis</p>	<p><b>ARG 2.3.1</b> (2.3.1- 21.1-015-HP; 2.3.1- 21.1-016-HP)</p> <p><b>ARG 2.3.8</b> (2.3.8-21.1-020-HP; 2.3.8-21.1-021-HP; 2.3.8-21.1-022-HP; 2.3.8-21.1-023-HP)</p> <p><b>ARG 1.3.5</b> (1.3.5- 21.1-007-HP)</p> <p><b>ARG 2.3.6</b> (2.3.6- 21.1-018-HP)</p> <p><b>ARG 1.2.3</b> (1.2.3- 21.1-002-HP)</p> <p><b>ARG 1.3.1</b> (1.3.1- 21.1-004-HP; 1.3.1- 21.1-003-HP))</p> <p><b>ARG 1.3.3</b> (1.3.3- 21.1-005-HP; 1.3.3- 21.1-006-HP)</p> <p><b>ARG 2.3.7</b> (2.3.7- 21.1-019-HP)</p> <p><b>ARG 2.1.5</b> (2.1.5- 21.1-009-HP)</p> <p><b>ARG 2.1.6</b> (2.1.6- 21.1-011-HP; 2.1.6- 21.1-012-HP)</p> <p><b>ARG 2.2.1</b> (2.2.1- 21.1-013-HP; 2.2.1- 21.1-014-HP)</p> <p><b>ARG 4.1.2</b> (2.2.1- 21.1-025-HP)</p> <p><b>ARG 4.5</b> (4.5-21.1-026-HP)</p> <p><b>ARG 4.5.3</b> (4.5.3-21.1-027-HP)</p>
<p>Tools/Methods selected out of the HP repository</p>	<p>Workload - NASA TLX</p> <p>Situational Awareness - SASHA</p>
<p>summary of the HP activity</p>	<p>Real Time Simulation simulating Barcelona Airport. The analysis was carried out by questionnaires and debriefing sessions.</p>

**Table 7: Description of Activity 3**

ACTIVITY 4.	
Description	Validation Exercise <b>PJ.02-21 Val EXE 4</b> "Integrated Validation for Enhanced Ground System", conducted by <b>LEONARDO</b> , is running Real-Time Simulations to validate the new and enhanced alerts introduced by Solution PJ.02-W2-21.1 (see VALP part I [7], section 5.3 and Appendix B).
Related Arguments	<p><b>ARG 2.3.1</b> (2.3.1- 21.1-015-HP; 2.3.1- 21.1-016-HP)</p> <p><b>ARG 2.3.8</b> (2.3.8-21.1-020-HP; 2.3.8-21.1-021-HP; 2.3.8-21.1-022-HP)</p> <p><b>ARG 1.2.3</b> (1.2.3- 21.1-002-HP)</p> <p><b>ARG 1.3.1</b> (1.3.1- 21.1-004-HP; 1.3.1- 21.1-003-HP))</p> <p><b>ARG 1.3.3</b> (1.3.3- 21.1-005-HP; 1.3.3- 21.1-006-HP)</p> <p><b>ARG 2.3.7</b> (2.3.7- 21.1-019-HP)</p> <p><b>ARG 2.1.5</b> (2.1.5- 21.1-009-HP)</p> <p><b>ARG 2.1.6</b> (2.1.6- 21.1-011-HP; 2.1.6- 21.1-012-HP)</p> <p><b>ARG 2.2.1</b> (2.2.1- 21.1-013-HP; 2.2.1- 21.1-014-HP)</p> <p><b>ARG 3.3.5</b> (3.3.5- 21.1-024-HP)</p> <p><b>ARG 4.5</b> (4.5-21.1-026-HP)</p> <p><b>ARG 4.5.3</b> (4.5.3-21.1-027-HP)</p> <p><b>ARG 2.3.4</b> (2.3.3-21.1-017-HP)</p>
HP objectives	<p><b>OBJ-02.21.1-V3-VALP-001</b> To evaluate if the HMI is suitable for the controller to assess the new alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-001</b> To assess the impact of the new and updated Safety Support Tools on the Human Performance.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-002</b> To assess the ATCOs understanding of the conditions triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-003</b> To assess the ATCOs level of trust in the automated function triggering the new and updated alerts.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-004</b> To assess that the updated and new alerts are satisfying the needs to support the controller</p> <p><b>OBJ-02.21.1-V3-VALP-HP-007</b> To collect the training needs required to prepare the ATCOs for the operation of the new/updated safety nets.</p> <p><b>OBJ-02.21.1-V3-VALP-HP-008</b> To assess that the HMI design supports the viewer in recognizing the displayed safety-critical situations.</p>

Issues to be addressed / investigated from issues analysis	2.3.1- 21.1-015-HP 2.3.1- 21.1-016-HP 2.3.8-21.1-020-HP 2.3.8-21.1-021-HP 2.3.8-21.1-022-HP 1.2.3- 21.1-002-HP 1.3.1- 21.1-004-HP 1.3.1- 21.1-003-HP 1.3.3- 21.1-005-HP 1.3.3- 21.1-006-HP 2.3.7- 21.1-019-HP 2.1.5- 21.1-009-HP 2.1.6- 21.1-011-HP 2.1.6- 21.1-012-HP 2.2.1- 21.1-013-HP 2.2.1- 21.1-014-HP 3.3.5- 21.1-024-HP 4.5-21.1-026-HP 4.5.3-21.1-027-HP  2.3.3-21.1-017-HP
Tools/Methods selected out of the HP repository	Validation Exercise <b>PJ.02-21 Val EXE 4</b> used an adaptation of the Workload-NASA TLX and Situational awareness-SASHA methods based which could best fit acceptability, utility, usability, safety judgements by the ATCOs
summary of the HP activity	The analysis was carried out by questionnaires and debriefing sessions.

**Table 8: Description of Activity 4**

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

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

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Obj. ID	Valid. activity conducted	results / evidence	recommendations	requirements
<b>Arg. 2.3.1. The type of information provided satisfies the information requirements of the human.</b>							
2.3.1-21.1-015-HP	<b>ISSUE:</b> The controller is not able to take action based on the information given by the new alerts, because the information is incomplete or unclear.	Closed	OBJ-02.21.1-V3-VALP-001.	Real Time Simulation Shadow-Mode Trial	The validation exercises EXE01, EXE03 and EXE04 showed that the alerting HMI supports the ATCO in perceiving and interpreting information helping them to take the proper action to solve the problem. In the case of EXE03 ATCO highlighted the utility of the predictive indicator.		
2.3.1-21.1-016-HP	<b>BENEFIT:</b> The information provided by the new alerts gives the controller the information required to solve the problem.	Closed	OBJ-02.21.1-V3-VALP-001	Real Time Simulation Shadow-Mode Trial	The questionnaires and the debriefing sessions in the validation exercises EXE01, EXE03 and EXE04 shown that the alerting HMI provides the right information to the controller. The outcomes of the exercises indicated that the information provided by the prototype allowed to properly		

					assess and understand the new alerts.		
<b>2.3.8 Arg. 2.3.8: The user interface supports a sufficient level of individual situation awareness. [V1: AIR only]</b>							
2.3.8-21.1-020-HP	<b>BENEFIT:</b> Identification of mobiles involved in the conflicting situation indicated by the alert is easily recognizable.	Closed	OBJ-02.21.1-V3-VALP-001	Real Time Simulation Shadow-Mode Trial	In EXE01 and EXE03 ATCOs indicated that the alerting HMI showed the involved mobiles clearly highlighted and easily identifiable. However, the outcomes of EXE04 indicated that when there were several alerts and more than two mobiles involved in a situation, ATCOs sometimes had issues determining the pairs of conflicting mobiles.	<b>ALERT-RECOM-03-21.1-001.</b> The system should use a presentation style in colour coding or overlays to allow easily identifying visually which alert involve which mobile.	
2.3.8-21.1-021-HP	<b>BENEFIT:</b> Information displayed by the alerting HMI is in agreement with information displayed by other user interfaces of the CWP.	Closed	OBJ-02.21.1-V3-VALP-001	Real Time Simulation Shadow-Mode Trial	ATCO answered in the questionnaires of EXE03 “strongly agree” to the success criteria SC008, which confirms that the HMIs available in the validation setup display consistent information. In the case of EXE01 the controllers didn’t deny the consistency of the information on the HMIs available in the validation setup.		
2.3.8-21.1-022-HP	<b>BENEFIT:</b> The alerts displayed are consistent with	Closed	OBJ-02.21.1-V3-VALP-001	Real Time Simulation	ATCOs rated this success criteria (SC009) as “agree” in both exercises (EXE01 and EXE03)		

	the traffic development.			Shadow-Mode Trial			
2.3.8-21.1-023-HP	<p><b>BENEFIT:</b> CATC Predictive Indication gives a reliable prediction of the impact of the next clearance to be given to a mobile.</p>	Closed	V3-VALP-003	Real Time Simulation Shadow-Mode Trial	<p>Predictive indication was considered as useful and very useful in EXE01 and EXE03 (respectively). Moreover, ATCOs in EXE01 highlighted that the predictive Indication was especially <b>useful in adverse weather conditions</b> (without a view to the outside) in particular to CATC Predictive Indication for Runway Operations where it is extremely important that the controller perceives and interprets information relevant to the task. In EXE03 ATCOs indicated that the configurability of</p>	<p><b>ALERT-RECOM-03-21.1-002.</b> The system should allow to <b>turn on and off each CATC subtypes.</b></p> <p><b>ALERT-RECOM-03-21.1-003.</b> The system should allow to turn on and off the subtypes of alerts in the <b>predictive indicator.</b></p> <p>Moreover, this configurability of the <b>subtypes of the predictive indicator</b> has to be <b>independent to the configurability of alerts</b> (the same specific subtype of CATC alert</p>	

					the predictive indicator for each CATC subtypes would be highly value, moreover ATCOs highlighted that the system should offer the possibility to configurate subtypes of alerts in the predictive indicator independently of the configurability of the alerts, that means that a specific subtype of CATC alert could be "on" for the alerts but "off" for the predictive indicator (and vice versa)	could be "on" for the alerts but "off" for the predictive indicator and vice versa.	
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1.3.5. Human actors can maintain a sufficient level of situation awareness

1.3.5-21.1-007-HP	<b>BENEFIT:</b> The controller uses the CATC Predictive Indication to update his/her awareness for possible critical situations caused by conflicting clearances.	Closed	OBJ-02.21.1-V3-VALP-003.	Real Time Simulation Shadow-Mode Trial	In EXE01and EXE03 ATCOs agree and strongly agreed (respectively) that CATC Predictive indication was very useful to increase situational awareness, to avoid entering conflicting clearances.		
1.3.5-21.1-008-HP	<b>ISSUE:</b> The use of the CMAC STAND OCCUPIED alert for informing the controller when a stand is currently occupied might lead to a potential	Closed	OBJ-02.21.1-V3-VALP-301	Real Time Simulation	During the debriefing sessions and in the questionnaires ATCOs of EXE03 gave positive feedback of the CMAC Stand occupied alert. However, this alert covers conflictive situation less critical than the others, so they suggested that it should be considered more of a		<b>ALERT-REQ-02-21.1-001:</b>  The visual display of the CMAC Stand occupied alert shall be clearly distinguishable



<p>increase in human operator's situational awareness</p>				<p>warning than an alert. As this alert was less critical the visual display of this alert generated confusion as it was presented with alerting HMI similar to other more critical alerts.</p> <p>The visual display of the CMAC Stand occupied alert caused confusion as it was presented using an HMI similar to other more critical alerts. In the ATCO debriefings a specific and differentiated visual representation was suggested for this alert.</p> <p>HMI presented during the validation:</p>		<p>from CATC or CMAC alerts.</p>
				 <p>HMI proposed:</p> 		

2.3.6 The usability of the user interface (input devices, visual displays/output devices, alarm& alerts) is acceptable. [V1: AIR only]						
2.3.6-21.1-018-HP	<b>ISSUE:</b> The usability of the CATC Predictive Indication is not acceptable.	Closed	OBJ-02.21.1-V3-VALP-004	Real Time Simulation Shadow-Mode Trial	ATCOs confirmed that the Predictive Indication is useable and supports the execution of the normal tasks of a controller. ATCOs confirmed its usability (specially ATCOs in EXE03).	
1.2.3 Operating methods cover degraded modes of the ATM system.						
1.2.3-21.1-002-HP	<b>ISSUE:</b> The controller might use the CATC Predictive Indication to update his situational awareness. The controller needs to know if he can rely upon the indication.	Closed	OBJ-02.21.1-V3-VALP-HP-001	Real Time Simulation Shadow-Mode Trial	ATCOs in EXE01 confirmed that they can control traffic without the assistance of the CATC service in the event that the service is degraded or unavailable.	
1.3.1 The potential for human error is reduced as far as possible.						

1.3.1-21.1-003-HP	<p><b>ISSUE:</b> In case the new alerts generate too many nuisance alerts this might lead to misunderstandings of the human operator and to mistakes based on the alerts displayed. In addition, the nuisance alerts might distract the human operator from his/her current tasks, leading to a potential increase in human errors.</p>	Closed	OBJ-02.21.1-V3-VALP-HP-001	Real Time Simulation Shadow-Mode Trial	The overall rate of false and nuisance alerts is acceptable to the ATCOs.		
1.3.1-21.1-004-HP	<p><b>BENEFIT:</b> Controller decisions are less prone to errors by using CATC Predictive Indication</p>	Closed	OBJ-02.21.1-V3-VALP-HP-001	Real Time Simulation Shadow-Mode Trial	<p>ATCOs consider predictive indication as a tool that reduces the likelihood of human error as much as possible and confirm that the Predictive Indication helps to avoid entering clearances that can lead to safety critical traffic developments.</p> <p>Even if the CATC subtype link to the predictive indicator is “off” the predictive indicator still presents a benefit.</p>		

1.3.3 The level of workload (induced by cognitive and/or physical task demands) is acceptable.

<p>1.3.3-21.1-005-HP</p>	<p><b>ISSUE:</b> The new alerts displayed in the HMI might increase the level of attention and cognitive demand for the human operator, as potentially a higher number of alerts will need to be assessed.</p>	<p>Closed</p>	<p>OBJ-02.21.1-V3-VALP-HP-001</p>	<p>Real Time Simulation Shadow-Mode Trial</p>	<p>In EXE01, EXE03 and EXE04 ATCOs confirm that the workload in the solution is not significantly higher than in the reference scenario.  ATCOs in EXE03 indicated that they prefer not to feed the system (i.e. introducing the runway exit, ....). If it is necessary to feed the system they would prefer to have available a menu with all the options and check one of them (but they prefer avoiding to write).</p>	<p><b>ALERT-RECOM-03-21.1-004.</b> When it is required that the ATCO feeds the system, a menu with the different options should be provided by the system (ATCOs prefer to choose an option in the menu avoiding write)</p>
<p>1.3.3-21.1-006-HP</p>	<p><b>BENEFIT:</b> The new CATC alert informs the controller early on of the potential conflict that is to be resolved and gives additional time to solve the situation.</p>	<p>Closed</p>	<p>OBJ-02.21.1-V3-VALP-HP-001&amp;004</p>	<p>Real Time Simulation Shadow-Mode Trial</p>	<p>Regarding the impact on workload due to the early detection of conflictive clearances, ATCOs confirm that without the new enhanced alerts an increasing workload would raise if the clearance conflict develops into a safety incident. ATCOS confirm that the new alerts (thanks to the timely alert) reduce the workload of solving the situation that could arise if the ATCO reacted too late.  The timing of the alerts was considered perfect to avoid nuisance alerts (the alerts are triggered in good time to react and solve the conflicting situation)</p>	

2.3.7 The user interface design reduces human error as far as possible. [V1: AIR only]						
2.3.7-21.1-019-HP	<b>BENEFIT:</b> The User Interface design clearly visualises the alerting information.	Closed	OBJ-02.21.1-V3-VALP-HP-001	Real Time Simulation Shadow-Mode Trial	ATCOs in EXE01 and EXE03 provided a positive feedback regarding the HMI.  In the case of EXE04 ATCO had problems to identify the aircraft involved in the conflict (see recommendation ALERT-RECOM-02-21.1-001)	
2.1.5 Human actors can acquire an adequate mental model of the machine and its automated functions						
2.1.5-21.1-009-HP	<b>ISSUE:</b> The controller does not understand the rules and conditions that trigger the new CMAC alerts. Consequently, s/he is not able to correctly assess the situation and the conflicting clearances.	Closed	OBJ-02.21.1-V3-VALP-HP-002	Real Time Simulation Shadow-Mode Trial	ATCOs in EXE01 and EXE04 confirmed that their understanding of CATC detection meets the controller's task requirements and can retrace the alert trigger conditions.  However, in the case of EXE03 ATCOS showed a positive feedback in all the alerts <b>except for TOF/LND, LND/LND and CRSS/LND</b> . The result of the validation is considered partly OK for the use in ENAIRE of the principle of reasonable assurance based on traffic location, while the enhanced alerts are based on	<b>ALERT-REQ-02-21.1-002:</b>  ATCOs shall be provided by a safety support service that supports the local ATC procedures and the corresponding practices (especially relevant for TOF/LND, LND/LND and CRSS/LND alerts)

					<p>runway occupancy time prediction. This difference in criteria caused:</p> <ul style="list-style-type: none"> <li>• ENAIRE's ATCO <b>require an alert when the aircraft is at certain locations on the RWY</b> even if the time to threshold for the landing aircraft is larger than the time to vacate the RWY for the preceding traffic. The non-trigger of the alert in such situations is identified by ENAIRE ATCO as a worsening compared to SESAR 1 CATC alerts.</li> </ul> <p>To summary the validation exercises performed in different countries has demonstrated that there are two valid versions of LND/LND, CRS/LND and TOF/LND alerts: version of Solution #02 in SESAR1 (i.e. for EXE03) or the version of PJ.02-W2-21.1 (i.e. for EXE01).</p>		
2.1.6 The level of trust in automated functions is appropriate.							
2.1.6-21.1-011-HP	<p><b>BENEFIT:</b> The controller trusts the new alerts and prediction indications provided</p>	Closed	OBJ-02.21.1-V3-VALP-HP-003	Real Time Simulation Shadow-Mode Trial	During the debriefing sessions and questionnaires in EXE03 and EXE01 ATCOs confirmed that the alerts were useful and if were		

	by the Safety Support Tools. S/he considers the information provided and accepts the system support to monitor the traffic development.				implemented they would not ignore them		
2.1.6-21.1-012-HP	<b>ISSUE:</b> The controller has a too high degree of trust in the new Safety Support Tools and relies on the system to trigger an alert in case the controllers attention is required. As a result the controller neglects his/her task to monitor the traffic	Closed	OBJ-02.21.1-V3-VALP-HP-003	Real Time Simulation Shadow-Mode Trial	During the debriefing sessions and questionnaires in EXE03 and EXE01 ATCOs confirmed that they would not neglect their monitoring task in expectation that the safety net would detect the critical situation.		
<b>2.2.1 The accuracy and timeliness of information provided by the system is adequate for carrying out the task.</b>							
2.2.1-21.1-013-HP	<b>BENEFIT:</b> The information given in the new alerts is complete and accurate. This enables the	Closed	OBJ-02.21.1-V3-VALP-HP-004	Real Time Simulation Shadow-Mode Trial	ATCOs in EXE01 and EXE03 confirmed that the information provided by the CATC Alerting was in line with their information needs and met their requirements for dealing with the conflict situation.		

	controller to manage the conflict situation						
2.2.1-21.1-014-HP	<b>BENEFIT:</b> The controller receives the alert in time to use the information provided to manage the conflict situation.	Closed	OBJ-02.21.1-V3-VALP-HP-004	Real Time Simulation Shadow-Mode Trial	ATCOs rated as “strongly agree” or “agree” when they were asked about this question. ATOCs in EXE03 and EXE01 confirmed that the alerts were triggered in good time to react and solve the conflicting situation (not too late) neither triggered too early to be operationally relevant. Moreover the alerts were terminated correctly when the conditions no longer apply.		
<b>3.3.5 Team members can maintain a sufficient level of shared situation awareness</b>							
3.3.5-21.1-024-HP	<b>BENEFIT:</b> Controllers are aware of the critical situations taking place in the AoR of other controllers.	Closed	OBJ-02.21.1-V3-VALP-HP-005	Real Time Simulation Shadow-Mode Trial	ATCOs of EXE03 confirmed that they were aware of the critical situations taking place in the AoR of other controllers		
<b>4.1.2 The impact of changes on the job satisfaction of affected human actors has been considered.</b>							
4.1.2-21.1-025-HP	<b>BENEFIT:</b> If the new alerts are proven to be accurate, complete and usable	Closed	OBJ-02.21.1-V3-VALP-HP-006	Real Time Simulation Shadow-Mode Trial	ATCOs were asked about the changes in roles and responsibilities introduced by the new alerts and their impact on the job satisfaction. ATCOs in EXE01 and EXE03		



	(timeliness), their operation will not lead to a reduced job satisfaction perceived by the human operator.				considered that no negative impacts were identified, so job satisfaction doesn't decrease with the use of this new functionalities.  The SC002 could not be evaluated.	
<b>4.5 Training needs are identified for affected human actors. (V3 only)</b>						
4.5-21.1-026-HP	<b>ISSUE:</b> The information that needs to be covered to the controller in the training on the new alerts has to be specified. The adequate training enables the controller to recognise the alert, perceive the information provided and to decide what actions need to be executed.	Closed	OBJ-02.21.1-V3-VALP-HP-007	Real Time Simulation Shadow-Mode Trial	During the debriefing sessions of EXE01, EXE03, and EX04 ATCOs stated their training needs and made recommendations.	<p><b>ALERT-REQ-02-21.1-004:</b> The Safety Support Tools training shall address the surveillance and the routing and planning service.</p> <p><b>ALERT-REQ-02-21.1-005:</b> The Safety Support Tools Training should be conducted using practical examples that include local traffic situations at the trainee's airport</p> <p><b>ALERT-REQ-02-21.1-006:</b> The Safety Support Tools Training should use continuous on-the-job knowledge support, i.e., refresher training coaching, and</p>

							dedicated contacts among colleagues.
4.5.3 The required types of training (i.e. classroom, simulator, on-the job training) are identified. (V3 only)							
4.5.3-21.1-027-HP	<b>ISSUE:</b> The “Type of training” (e.g. classroom, simulator, on-the-job training) needs to be identified to provide an comprehensive training on all aspects of the new alerts. (trade the pros and cons of the different settings and identify what needs compensation if it cannot be provided in a specific setting).	Closed	OBJ-02.21.1-V3-VALP-HP-007	Workshop	During the debriefings of the validation exercises ATCOs discussed the Pros and Cons of the possible training types.		<b>ALERT-REQ-02-21.1-003:</b> The Safety Support Tools training should consist of two parts: theoretical and simulator training.
2.3.4 Alarms and alerts have been developed according to HF principles. [V1: AIR only]							
2.3.4-21.1-017-HP	<b>ISSUE:</b> The colour-coding, alert-naming, and alert label look and feel might lack a global visual	Closed	OBJ-02.21.1-V3-VALP-HP-008.	Real Time Simulation Shadow-Mode Trial	The visual display was designed according to HF principles. The diversity of alerting HMI, their recognition and location in both track data label and flight electronic strip are considered well		

<p>coherence, what causes the controller to lose track of the situation indicated by the new alerts</p>			<p>implemented to identify and evaluate conflicts. The following conclusions were drawn from the debriefing sessions:</p> <ul style="list-style-type: none"> <li>• the alerting HMI integrated into the track label was considered to be well implemented, both in terms of design and location and allows for the assessment and identification of the conflict situation.</li> <li>• In the electronic flight strips, the Alerting HMI is also considered well implemented.</li> <li>• The individual alert window presented in both track label and electronic flight strips helps to identify and evaluate the alert.</li> </ul>		
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Table 9: Summary of the HP results and recommendations/ requirements for each identified issue & related argument

#### 4.4.2 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 V-phase.

PJ.02-W2-21.1 has performed this Human Performance Report following the guides and steps of the HP reference material. As a result an overall of 11 issues and 14 benefits included in Section 4.4.1 and in the HP log included in the Validation Plan were initially identified.

As consequence all the identified issues and benefits initially identified (after analysing the impact of the change introduced by the concept) were used to try to improve the concept and translated to Human Performance objectives. All of them were correctly evaluated in the validation activities and as a result all the benefits and issues have been closed. The feedback of the ATCOs when they were asked about the new enhanced safety alerts were very positive. No critical issues were identified during the validation activities. However, the evaluation concluded that some aspects related to Human Performance could be improved, so 4 recommendations and 6 requirements were derived and included in the Final OSED [5] of the solution. Based in the evidence obtained it can be concluded that Solution PJ.02-W2-21.1 have achieved V3.

Maturity checklist for finalising the V3 assessment			
ID	Question	Answer.	Comments
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	YES	All the arguments were addressed as can be seen in section 4.4.1
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	YES	
3	Have all the parts of the solution/concept been considered?	YES	Initially the concept was carefully studied in order to detect all the potential issues and benefits. These issues were derived after analyzing the nature of the change introduced by the solution and translated into HP objectives.
4	Have potential interactions with related projects/concepts been considered and addressed?	NO	Solution PJ02-W2-21.1 depends on Solution #22 Routing and Planning, which is a pre-requisite to deploy PJ.02-W2-21.1. Routing and Planning provide essential information to identify safety-critical traffic developments. (Note: (Routing and Planning is also a prerequisite of #02)
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	YES	The potential issues and benefits identified were translate to Human Performance objectives No critical issues regarding HP were identified after evaluating the results of the validation activities. The identified aspects that could be improved have derived in several recommendations and requirements.

6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	YES	-
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	YES	The solution was assessed in a realistic environment and the validation exercises were performed by with end-users (ATCOs of different airports), however degraded or abnormal conditions were not simulated.
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	YES	The feedback regarding the new enhanced safety nets was very positive. The validation report concluded that the tool supported the controller enhancing their situational awareness and increasing safety.
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	YES	The results of this HPAR have been used as inputs for SAR [9] and OSED [5]
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	YES	
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	YES	Several recommendations and requirements have been derived (including training requirements).
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	YES	All the aspects regarding HP that could be improved have been derived in requirements and recommendations (see Appendix A and B)

13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	NO	The concept does not introduce any change in the roles and responsibilities of the controller.
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	YES	All the issues have been closed.

## 5 References

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### Human Performance

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- [1] 16.06 Strawman Paper on Case Building in SESAR SWP 16.6
- [2] 16.04.01 Evolution from the ATM HF case to a HP Case Methodology for SESAR, HP assessment process for projects in V1, V2 or V3. D10-001, 00.01.00
- [3] 16.06.05 D 27 HP Reference Material D27
- [4] 16.04.02 D04 e-HP Repository - Release note

### PJ02-W2-21-1 References

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- [5] SESAR Solution PJ.02-W2-21.1 – D6.1.002 - SPR/INTEROP OSED for V3 – Part I, edition 00.02.02, 24 May 2023.
- [6] SESAR Solution PJ.02-W2-21.1 - D6.1.004 - VALP - Part IV - HP Assessment Plan, edition 00.01.00, , 26 August 2021.
- [7] SESAR Solution PJ.02-W2-21.1 - D6.1.004 - VALP - Part I, edition 00.01.00, 26 August 2021.
- [8] SESAR Solution PJ.02-W2-21.1 - D6.1.006 - Validation Report (VALR) for V3, , edition 00.01.02, 24 May 2023.
- [9] SESAR Solution PJ.02-W2-21.1- D6.1.002 - SPR-INTEROP/OSED for V3 -Part II-SAR, edition 00.01.02, 24 May 2023.



## Appendix A – HP Recommendations Register

HP Recommendations Register									
Reference	Type of recommendation	Recommendation	Rationale	Assessment source + Reference report	Scope (Air, Air/Ground, Ground)	Concept/solution Involved	Recommendation status	Rationale in case of rejection	Comments
ALERT-RECOM-02-21.1-001	Other	The system should use a presentation style in colour coding or overlays to allow easily identifying visually which alert involve which mobile.	The outcomes of EXE04 indicated that when there were several alerts and more than two mobiles involved in a situation, ATCOs sometimes had issues determining the pairs of conflicting mobiles.	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		
ALERT-RECOM-02-21.1-002	Other	The system should allow to turn on and off <b>each CATC subtypes</b> .	In EXE03 ATCOs indicated that the configurability of the subtypes of alerts would be highly valued. The Tower should be able to turn each CATC subtypes on and off.	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		
ALERT-RECOM-02-21.1-003.	Other	The system should allow to turn on and off the subtypes of alerts in the <b>predictive indicator</b> .	In EXE03 ATCOs indicated that the configurability of the predictive indicator for each CATC subtypes would be highly value, moreover ATCOs	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I	Ground	PJ.02-W2-21.1	Accepted		

		Moreover, this configurability of the <b>subtypes of the predictive indicator</b> has to be <b>independent to the configurability of alerts</b> (the same specific subtype of CATC alert could be "on" for the alerts but "off" for the predictive indicator and vice versa).	highlighted that the system should offer the possibility to configurate subtypes of alerts in the predictive indicator independently of the configurability of the alerts, that means that a specific subtype of CATC alert could be "on" for the alerts but "off" for the predictive indicator (and vice versa).	(November 2022)					
ALERT-RECOM-03-21.1-004	OPS (operating methods/procedures)	When it is required that the ATCO feeds the system, a menu with the different options should be provided by the system (ATCOs prefer to choose an option in the menu avoiding write)	ATCOs in EXE03 indicated that they prefer not to feed the system (i.e. introducing the runway exit, ...). If it is necessary to feed the system they would prefer to have available a menu with all the options and check one of them (but they prefer avoiding to write).	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		

Table 10: HP recommendations

## Appendix B – HP Requirements Register

HP Requirements Register									
Reference	Type of requirement	Requirement	Rationale	Assessment source + Reference report if available	Scope (Air, Air/Ground, Ground)	Concept/solution Involved	Requirement status	Rationale in case of rejection	Comments
ALERT-REQ-02-21.1-001	HP Issue	The visual display of the CMAC Stand occupied alert shall be clearly distinguishable from CATC or CMAC alerts.	The visual display of the CMAC Stand occupied alert indicates a planning issue. This shall be clearly identifiable as an alert of low criticality. Otherwise, it might be confused with a CATC or CMAC alert.	1.3.5- 21.1-008-HP	Ground	PJ.02-W2-21.1	Accepted		
ALERT-REQ-02-21.1-002	HP Issue	ATCOs shall be provided by a safety support service that supports the local ATC procedures and the corresponding practices (especially relevant for TOF/LND, LND/LND and CRSS/LND alerts)	Validation exercises performed in different countries have demonstrated that there are two valid versions for LND/LND, CRS/LND and TOF/LND alerts: the version of Solution #02 in SESAR1 (i.e. for EXE03) and the version of PJ.02-W2-21.1 (i.e. for EXE01).	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		
ALERT-REQ-02-21.1-003	Training	The Safety Support Tools training should consist of	ATCOs pointed out that it is essential to provide 2 types of training prior to the implementation of these alerts:	PJ.02-W2-21.1 Validation Report	Ground	PJ.02-W2-21.1	Accepted		

		two parts: theoretical and simulator training.	<b>Theoretical training</b> (to correctly understand the activation and termination conditions of each alert) and <b>Simulator training</b> to become familiar with the alerts.	(VALR) for V3 - Part I (November 2022)					
ALERT-REQ-02-21.1-004	Training	The Safety Support Tools training shall address the surveillance and the routing and planning service.	The Safety Support Tools are an integrated part of the A-SMGCS. The interaction of surveillance, routing and planning and safety support tools shall be considered in the training.	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I	Ground	PJ.02-W2-21.1	Accepted		
ALERT-REQ-02-21.1-005	Training	The Safety Support Tools Training should be conducted using practical examples that include local traffic situations at the trainee's airport	Air traffic controllers shall learn the specifics of the Safety Support Tools used at their airport and not the "similar" solution used at any other airport. Rational: It is expected that the Safety Support Tools require local implementation to get their full potential.	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		
ALERT-REQ-02-21.1-006	Training	The Safety Support Tools Training should use continuous on-the-job knowledge support, i.e., refresher training, coaching, and dedicated contacts among colleagues.	Changes to the airport layout, changes affecting the procedures, improvements of the conflict detection function, and changes to the HMI shall be communicated regarding their relevance for the understanding of the Safety Support Tools.	PJ.02-W2-21.1 Validation Report (VALR) for V3 - Part I (November 2022)	Ground	PJ.02-W2-21.1	Accepted		

Table 11: HP Requirements



Beneficiaries contributing to Solution PJ.02-W2-21.1

