

Guidelines Validation Report

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Abstract

This report presents the results of the validation activities conducted within the HUCAN project for **Solution 0446 – Preliminary Guidelines to design ATM-related systems based on higher levels of automation**. The validation was carried out remotely through the establishment and consultation of an Expert Group (EG), which provided feedback, comments, and suggestions regarding the validity, usefulness, and applicability of the proposed approach. The outcome of the validation was generally positive.

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HUCAN

HOLISTIC UNIFIED CERTIFICATION APPROACH FOR NOVEL SYSTEMS BASED ON
ADVANCED AUTOMATION

HUCAN

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Table of contents

Abstract	1
1 Executive summary	7
2 Introduction	8
2.1 Purpose of the document.....	8
2.2 Intended readership	8
2.3 Background	8
2.4 Structure of the document.....	8
2.5 Glossary of terms.....	8
2.6 List of acronyms	10
3 Context of the validation	12
3.1 Preliminary remarks	12
3.2 SESAR solution 0446: a summary	13
3.3 Summary of the validation plan	14
3.4 Deviations	18
4 SESAR solution 0446 validation results	19
4.1 Summary of SESAR solution 0446 validation results.....	19
4.2 Detailed analysis of SESAR solution validation results per validation objective	19
4.3 Confidence in validation results	20
5 Conclusions and recommendations.....	22
5.1 Conclusions	22
5.2 Recommendations.....	22
6 References	25
6.1 Applicable documents	25
6.2 Reference documents	25

List of tables

Table 1. Glossary of terms.....	10
Table 2. List of acronyms.....	11
Table 3. Experts involved in validation activities	15
Table 4. Validation plan and scheduling.....	15

Table 5. HUCAN validation objective and success criteria	16
Table 6. Exercise SOL.2#	18
Table 7. Exercise SOL.2# Trace	18
Table 8. Summary of validation exercises results	19
Table 9. OBJ-HUCAN-TRL2-TVAL.02 Results - Detailed overview	20

List of figures

Figure 1. HUCAN Preliminary Guidelines – Rationale.	14
Figure 2. HUCAN Design Toolkit – Example.....	14

1 Executive summary

This document presents the validation results for SESAR Solution 0446 – *Preliminary Guidelines to design ATM-related systems based on higher levels of automation*. This solution consists of a set of preliminary guidelines designed to support Research and Innovation (R&I) projects in adopting a certification-aware design and validation approach within the SESAR framework. Specifically, these guidelines promote the progressive alignment of concepts and solutions with the relevant certification objectives that can—or should—be addressed at each technology maturity level. The approach aligns with the building blocks outlined in the EASA AI Roadmap 2.0 (EASA, 2023), encompassing concept design, technical assurance (including safety and security), human factors, and ethics. In light of new references introduced for the certification of AI-enabled systems, HUCAN D5.2 analysed the corresponding SESAR subprocesses, as described in the SESAR 3 JU Project Handbook, and compared them with the EASA Concept paper (EASA, 2024(a)). Based on this comparative analysis between the EASA and SESAR approaches, HUCAN D5.2 identified existing gaps within the SESAR development pipeline that should be addressed in order for SESAR to satisfy the EASA Concept paper. These gaps are used as foundational principles for Preliminary Guidelines and a supporting toolkit, to support the harmonization between SESAR innovation and EASA certification processes, particularly for solutions involving high levels of automation.

The validation exercise, defined as TVAL.02.0[HUCAN]-[SOL.2]-TRL1, was conducted via a structured consultation involving an Expert Group (EG) and a Stakeholder Consultation Group (SCG). Targeting TRL2, the process combined the presentation of the HUCAN D5.2 solution with the collection of expert feedback—focusing on its utility and comprehensiveness.

The EG generally provided positive feedback on the rationale of the gap analysis and the resulting Preliminary guidelines, particularly valuing that certification was addressed contextually within existing SESAR subprocesses. This approach strengthens the SESAR community’s existing know-how while maintaining the flexibility needed to support both exploratory research and compliance requirements.

Based on expert feedback and project objectives, Solution 0446 is considered validated. The EG gave a generally positive evaluation. Considering the TRL2 target, the validation outcome is deemed satisfactory.

2 Introduction

2.1 Purpose of the document

This document provides the validation report for **SESAR solution 0446 - Preliminary Guidelines to design ATM-related systems based on higher levels of automation**. It describes the results of the validation exercise defined in TVAL.02.0[HUCAN]-[SOL.2]-TRL1 and how it has been conducted, and provides a set of relevant conclusions and recommendations.

2.2 Intended readership

This document is addressed to the SESAR community, as well as to granting, regulatory, and certification bodies concerned with the scientific robustness of the proposed solutions. It aims to provide a contribution in promoting certification-aware design and validation approaches, thereby fostering future R&I in AI and high-level automation for aviation, and contributing to a more seamless transition from research to market deployment.

2.3 Background

SESAR Solution 0446 has drawn on the results previously developed within the project and documented in the following deliverables:

- D3.1 – *Certification methods and automation: benefits, issues and challenges*;
- D3.2 – *Innovative approaches to approval and certification*;
- D4.1 – *Case studies introduction: level of automation analysis and certification issues*; and
- D4.2 – *Performance-based requirements for advanced automation*.

2.4 Structure of the document

This document is structured into five sections. Following the introduction, readers will find an overview of the context of validation. This provides an overview of the SESAR solution 0446, as well as a brief description of the validation activities, and the deviations that have emerged. Next come the validation results and conclusions, complemented by a set of recommendations. A complete overview is available in the Executive Summary.

2.5 Glossary of terms

Term	Definition	Source of the definition
Advanced Automation	It refers to the use of a system that, under certain conditions, operates without direct human intervention.	ISO/IEC 22989:2022(en), 3.1.7

Air Traffic	All aircraft in flight or operating on the manoeuvring area of an aerodrome.	ICAO Annex 11 - ATS
Artificial Intelligence	Technology that can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with.	EASA AI Roadmap 2.0
Air Traffic Management	The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management - safely, economically and sufficiently - through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.	ICAO Doc 4444 - ATM
Certification	Any form of recognition in accordance with this Regulation, based on an appropriate assessment, that a legal or natural person, product, part, non-installed equipment, equipment to control unmanned aircraft remotely, aerodrome, safety-related aerodrome equipment, ATM/ANS system, ATM/ANS constituent or flight simulation training device complies with the applicable requirements of this Regulation and of the delegated and implementing acts adopted on the basis thereof, through the issuance of a certificate attesting such compliance	Regulation (EU) n. 2018/1139 Article 3(9)
ATM/ANS	Air traffic management and air navigation services covers all of the following: the air traffic management functions and services as defined in point (10) of Article 2 of Regulation (EC) No 549/2004; the air navigation services as defined in point (4) of Article 2 of that Regulation, including the network management functions and services referred to in Article 6 of Regulation (EC) No 551/2004, as well as services which augment signals emitted by satellites of core constellations of GNSS for the purpose of air navigation; flight procedures design; and services consisting in the origination and processing of data and the formatting and delivering of data to general air traffic for the purpose of air navigation	Regulation (EU) n. 2018/1139 Article 3(5)

ATM/ANS System	The aggregation of airborne and ground-based constituents, as well as space-based equipment, that provides support for air navigation services for all phases of flight	Regulation (EU) n. 2018/1139 Article 3(7)
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Table 1. Glossary of terms

2.6 List of acronyms

Term	Definition
AA	Advanced Automation
AI	Artificial Intelligence
AMPLE3	SESAR3 ATM Master Planning and Monitoring
ANS	Air Navigation Service(s)
ATM	Air Traffic Management
DES	Digital European Sky
DMP	Data Management Plan
EASA	European Union Aviation Safety Agency
EC	European Commission
EG	Expert Group
ERP	Exploratory Research Plan
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
GA	Grant Agreement
HE	Horizon Europe
HF	Human Factor(s)
HUCAN	Holistic Unified Certification Approach for Novel systems based on advanced automation
ID	Identifier
ISO	International Organization for Standardization

IT	Information Technologies
KPA	Key Performance Area
KPI	Key Performance Indicator
M	Month
ML	Machine Learning
PEARL	Performance Estimation, Assessment, Reporting and simulation
PO	Project Officer
R&I	Research & Innovation
RMT	Rule Making Task
SESAR	Single European Sky ATM Research
SESAR 3 JU	SESAR 3 Joint Undertaking
SRIA	Strategic Research and Innovation Agenda
TRL	Technology Readiness Level
VALP	Validation plan
VALR	Validation Report
WG	Working Group

Table 2. List of acronyms

3 Context of the validation

3.1 Preliminary remarks

The HUCAN project addresses the legal and regulatory challenges associated with increasing levels of automation in the ATM environment. This research initiative aligns with the Strategic Research and Innovation Agenda (SRIA) (SESAR JU, 2020), which highlights the need for new methodologies for the validation and certification of advanced automation (AA) that ensure transparency, address legal considerations, and guarantee robustness and stability under all conditions—particularly in operational ATM environments enabled by various Artificial Intelligence (AI)-based solutions. In response, the HUCAN project proposes a novel, holistic, and human-centred approach to the certification and approval of new ATM-related airborne and ground systems that incorporate higher levels of automation, including those based on AI and Machine Learning (ML).

From the beginning of the project, however, the legal framework on AI and advanced automation has considerably changed, especially in the European Union (EU). In particular, with the entrance into force of the EU AI Act (Reg. (EU) 2024/1689)², these evolutions have been affecting both the general audience as well as the aviation domain.

Accordingly, the project has read its objectives in light of these advancements, particularly focusing on the applicability of EASA strategic objectives for the certification of AI in aviation (EASA, 2023; EASA, 2024(a); EASA, 2024(b)) throughout the SESAR development pipeline.

This involved a review of the validation plan initially outlined in the Exploratory Research Plan (ERP – D1.2). In terms of substance, the strategy remains almost unchanged. However, it was necessary to slightly redefine the contents and the structure of the validation objectives, as well as the description of the exercises. All the occurred updates have been reported in the dedicated sections of this report.

In this regard, it is worth noting that HUCAN differs from other initiatives funded under the SESAR exploratory research framework. Rather than introducing a novel technical solution, the project proposes a set of preliminary guidelines and builds on well-established methods and use cases to innovate the design and validation approach. This aims to support certification-aware design in R&D projects focusing on AI and advanced automation in aviation. In line with the initial agreement with the Project Officer (PO), the activities to validate the developments did not involve the use of SESAR enablers or the SESAR architectural framework. Given that achieving the expected level of maturity in HUCAN primarily relies on desk research and expert consultation, the Expert Group (EG) appeared to be the most suitable technique for validating these outcomes and adequate for a solution that has to reach TRL2 by the end of the project. By collecting qualitative data—such as expert opinions, comments, and suggestions—the EG enables an impartial and objective evaluation of the quality of

² Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act).

the work. Additionally, the Stakeholder Consultation Group established within the project has also been consulted to ensure broader validation and alignment.

In line with the guidelines provided by the European Commission (EC) on Ethics and Data Protection in EU-funded research projects, and the HUCAN policy on data protection (as outlined in the DMP – D1.1), this document does not disclose the names of the experts involved in the validation activities, but rather reports the number of people involved, their roles and areas of expertise, in order to balance transparency with privacy. Their feedback and comments are presented in anonymous and aggregated form.

3.2 SESAR solution 0446: a summary

Solution 0446 consists of a set of preliminary guidelines designed to support Research and Innovation (R&I) projects in adopting a certification-aware design and validation approach within the SESAR framework. Specifically, these guidelines promote the progressive alignment of concepts and solutions with the relevant certification objectives that can—or should—be addressed at each technology maturity level.

By doing so, at each stage of development, solution owners can demonstrate that the investment behind their research activity aligns with certification goals. This contributes to reducing the gap between research and market entry, while also fostering a harmonised approach across SESAR projects.

These preliminary guidelines have been developed in line with the key performance areas identified in the EASA AI Roadmap 2.0 (EASA, 2023). These areas include concept design, technical assurance (including safety and security), human factors, and ethics.

In light of new references introduced for the certification of AI-enabled systems, HUCAN D5.2 analysed the corresponding SESAR subprocesses, as described in the SESAR 3 JU Project Handbook, and compared them with the objectives in the EASA concept paper. Based on this comparative analysis, HUCAN D5.2 has identified existing gaps within the SESAR development pipeline that would need to be addressed in order to satisfy the EASA concept paper. The preliminary guidelines reflect the intent to lay the foundational principles for the harmonization between SESAR system development and compliance pathways when high automation is addressed. As such, they aim to facilitate navigation of the new requirements within the R&I community, particularly within SESAR. Based on these preliminary guidelines, a practical toolkit has been derived to support the harmonisation activities. This toolkit includes several key components:

- Gap Analysis Checklists
- Overlaps and Gaps Mapping
- Traceability Matrix
- Templates for Documentation
- Recommendation Forms

The rationale behind the development process of this solution can be outlined as follows (Figure 1).

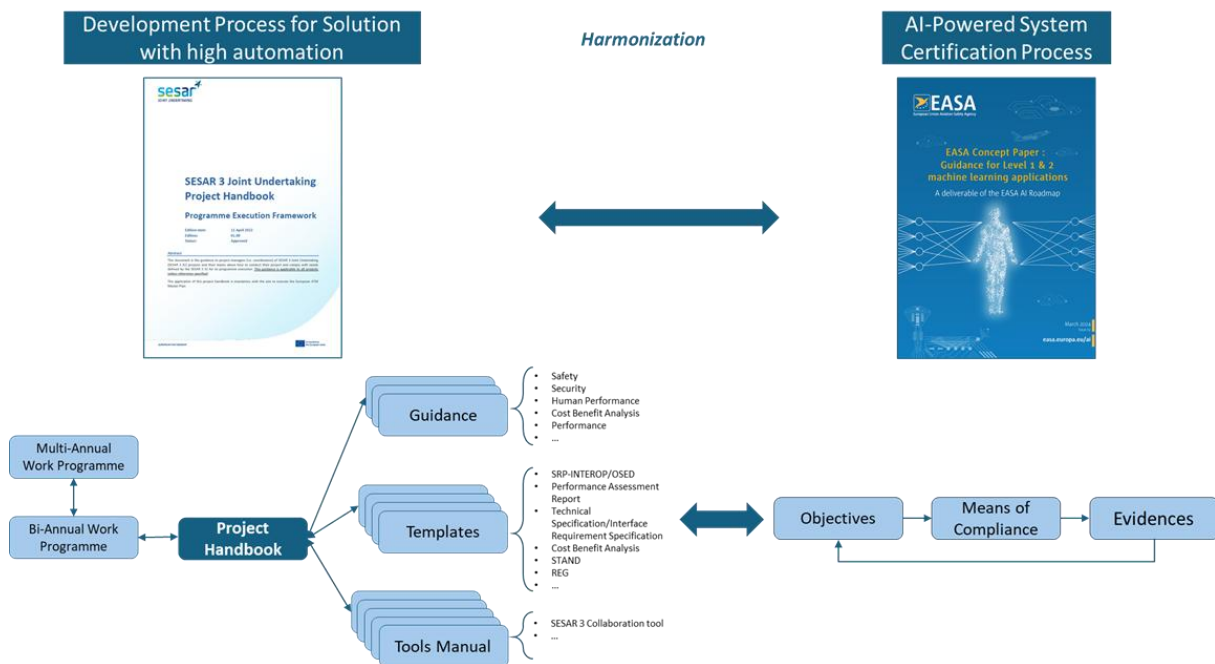


Figure 1. HUCAN Preliminary Guidelines – Rationale.

By way of example, the results produced can be represented as follows (Figure 2).

Subprocess	EASA Objective	SESAR Evidence		
		TRL2	TRL4-6	TRL8
Subprocess ID1	Objective ID1-01	ID1-01-TRL2-solution_doc1 - section_id ID1-01-TRL2-solution_doc2 - section_id ...	ID1-01-TRL4-2-solution_doc1 - section_id ID1-01-TRL4-2-solution_doc2 - section_id ...	ID1-01-TRL8-solution_doc1 - section_id ID1-01-TRL8-solution_doc2 - section_id ...
	Objective ID1-02	ID1-02-TRL2-solution_doc1 - section_id ID1-02-TRL2-solution_doc2 - section_id ...	...	...
	...	...	...	...
Subprocess ID2	Objective ID2-01	ID2-01-TRL2-solution_doc1 - section_id ID2-01-TRL2-solution_doc2 - section_id ...	ID2-01-TRL4-2-solution_doc1 - section_id ID2-01-TRL4-2-solution_doc2 - section_id ...	ID2-01-TRL8-solution_doc1 - section_id ID2-01-TRL8-solution_doc2 - section_id ...
	Objective ID2-02	ID2-02-TRL2-solution_doc1 - section_id ID2-02-TRL2-solution_doc2 - section_id ...	...	...
	...	...	...	...
...	...	...	...	...

Figure 2. HUCAN Design Toolkit – Example.

Further details can be found in Deliverable D5.2 – *Preliminary guidelines for advanced automation systems design and toolkit for guidelines application*.

3.3 Summary of the validation plan

3.3.1 Validation plan purpose

For the validation of this solution, and in line with the selected validation technique, HUCAN organised a series of meetings and interviews with qualified experts to collect feedback, comments, and

suggestions regarding the utility and comprehensiveness of the preliminary guidelines, particularly with a view to supporting their practical implementation within other SESAR projects.

These activities were conducted online, through both synchronous and asynchronous modes, and took place between M20 (April 2025) and M22 (June 2025), involving the following experts (Table 3) according to the validation plan as scheduled below (Table 4).

Organisation	Role	Expertise
EASA	ATM/ANS Expert	ATM/ANS
EASA	WG on EASA AI Roadmap	Software
EASA	WG on EASA AI Roadmap	ATM/ANS
EASA	WG on EASA AI Roadmap	HF
EASA	WG on EASA AI Roadmap	HF
Deep Blue	Head of Area	HF
Deep Blue	Head of Area	HF
Deep Blue	Head of Area	Environment

Table 3. Experts involved in validation activities

Organisation	Activity	Purpose	Iterations
EASA	Online feedback collection meetings	Collecting feedback and comments from the regulatory bodies regarding the validity and utility of the HUCAN preliminary guidelines	2
Deep Blue	Online feedback collection meetings	Collecting feedback and comments from R&I experts on the validity and utility of the HUCAN preliminary guidelines , in relation to the specific needs of SESAR projects	3

Table 4. Validation plan and scheduling

3.3.2 Summary of validation objectives and success criteria

The table below (Table 5) provides the updated description of the validation objective TVAL.02.0 as currently structured and success criteria associated with the SESAR solution 0446.

Validation objective(s) ID	Validation objective(s)	Success criteria
OBJ-HUCAN-TRL2-TVAL.02	Assess the validity and comprehensiveness of the HUCAN Preliminary Guidelines in light of the specific needs of SESAR R&I initiatives related to the alignment of design and validation activities with certification requirements for Artificial Intelligence (AI) and Advanced Automation (AA) in the aviation domain	The EG provides positive feedback on the validity and comprehensiveness of the HUCAN preliminary guidelines, in light of the specific needs of SESAR R&I initiatives related to the alignment of design and validation activities with certification requirements for Artificial Intelligence (AI) and Advanced Automation (AA) in the aviation domain

Table 5. HUCAN validation objective and success criteria

3.3.3 Validation assumptions

The HUCAN project is based on initial and intermediate assumptions which first emerged from a study of the state of the art, and were subsequently refined based on feedback collected with the support of the Stakeholder Consultation Group (SCG). The main assumptions that form the basis of the certification-aware approach to design and validation can be summarised as follows:

1. Future R&I projects focusing on AA and AI will increasingly be required to consider certification constraints and objectives from the earliest stages of system design. What is currently being observed is a growing awareness across the aviation research and innovation ecosystem that certification will no longer be an end-of-pipeline concern for solutions with a high maturity level, but rather an integral part of design planning, affecting strategic decisions throughout the development lifecycle.
2. Well-established certification processes are proving inadequate in the face of the challenges posed by highly automated solutions, particularly those based on AI. As documented by regulatory entities and granting authorities' initiatives, there is a growing need for adaptable, context-aware certification pathways that can be tailored to operational scenarios, technology maturity levels and automation profiles.
3. As certification becomes a strategic consideration from the outset, R&I actors will need to develop internal capabilities—not only in terms of technical expertise, but also regulatory literacy, particularly given the rapid evolution of regulatory ecosystems related to AI. Cross-functional collaboration (e.g., engineering, human factors, legal, ethics) will be essential to navigate this complexity.
4. The certification of solutions involving human-machine interaction in operational environments—particularly those with high levels of automation—requires novel design and validation approaches. These approaches should take into account the medium- and long-term implications of technology deployment, considering their impacts on the operational context,

modes of use, ethical aspects of interaction, and the human operator's capacity to maintain or regain control when necessary.

Due to the maturity level of SESAR-SOL.0446, it was not possible to apply the method directly. As previously mentioned, an Expert Group (EG) was therefore engaged to help investigate the project's contribution in relation to these assumptions, as part of a feedback collection exercise.

3.3.4 Validation exercise

Considering the evolution of the legal and regulatory framework over the course of the HUCAN project, as well as the refinement of its initial positioning and objectives, the scope and description of the dedicated validation exercise have been revised compared to what was initially outlined in the ERP. The updated description is provided below (Table 6 and Table 7).

Identifier	TVAL.02.0[HUCAN]-[SOL.2]-TRL1
Title	Validation of the Preliminary guidelines for advanced automation systems design and toolkit for guidelines application (D5.2)
Description	The feedback collection involves regulatory bodies, developers and deployers and SESAR R&I experts. The exercise is structured in two phases: • presentation of the HUCAN preliminary guidelines • collection of feedback, comments and suggestions
KPA/TA addressed	Safety, Security, HF, Ethics
Addressed expected performance contribution(s)	The expected contribution(s) aim(s) to: • Assess the validity of research approach and outputs • Assess the utility of the preliminary guidelines in R&I • Refine the preliminary guidelines, if needed
Maturity level	TRL2
Use cases	N/A
Validation technique	Expert group
Validation platform	N/A
Validation location	Online
Start date	M18
End date	M22

Validation coordinator	DBL
Status	<closed>
Dependencies	N/A

Table 6. Exercise SOL.2#

Linked Element Type	TVAL.02.0
<SESAR Solution>	TVAL.02.0
<Project>	HUCAN
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-HUCAN-TRL2-TVAL-002

Table 7. Exercise SOL.2# Trace

3.4 Deviations

3.4.1 Deviations with respect to the SESAR 3 JU project handbook

In line with the project objectives and research methodology as outlined in the proposal and approved in the GA, the Consortium has worked with the PO to proceed as described above. This approach, while deviating from the validation strategies conventionally adopted for concepts and technical solutions, has been mutually agreed.

3.4.2 Deviations with respect to the Exploratory Research Plan (ERP)

The deviation from the ERP can be summarised as follows:

- The UCs addressed by the project (D4.1) were utilised for the development of the certification-aware approach. Consequently, using only these scenarios for validating the preliminary guidelines would have compromised the substance and reliability of the final results.
- The direct involvement of regulatory bodies, along with R&I experts familiar with the SESAR validation framework, offers more relevant and insightful information regarding the validity and usability of the preliminary guidelines for both its intended application and potential future use.

4 SESAR solution 0446 validation results

4.1 Summary of SESAR solution 0446 validation results

The table below summarizes the results of the validation exercise, with reference to the OBJ-HUCAN-TRL2-TVAL.02, as originally defined in D1.2 and subsequently updated and restructured in the present document (Table 8).

Due to the specific nature of the HUCAN project and the adopted validation strategy, the layout differs slightly from the template versions. In particular, the columns dedicated to SESAR solution validation objective title and SESAR solution success criterion ID were removed, since not applicable.

SESAR solution validation objective ID	SESAR solution success criterion	SESAR solution validation results	SESAR solution validation objective status
OBJ-HUCAN-TRL2-TVAL.02	The EG provides positive feedback on the validity and comprehensiveness of the HUCAN preliminary guidelines, in light of the specific needs of SESAR R&I initiatives related to the alignment of design and validation activities with certification requirements for Artificial Intelligence (AI) and Advanced Automation (AA) in the aviation domain	The EG provided positive feedback	OK

Table 8. Summary of validation exercises results

4.2 Detailed analysis of SESAR solution validation results per validation objective

4.2.1 OBJ-HUCAN-TRL2-TVAL.02 results

Overall, the EG generally provided positive feedback on the utility and comprehensiveness of the HUCAN preliminary guidelines, particularly with regard to gap analysis carried out on the SESAR subprocesses.

The consulted experts provided positive feedback, particularly appreciating that the topic of certification was addressed contextually, within the existing SESAR subprocesses. This approach allows for the consolidation and reinforcement of existing know-how within the SESAR community, while maintaining sufficient flexibility to support exploratory research alongside compliance considerations.

The following two tables summarise the key feedback from EG members, grouped according to their respective affiliations (Table 9).

OBJ-HUCAN-TRL2-TVAL.01.01		
Organisation	Feedback	Comment(s)/Suggestion(s)
EASA	Positive	EASA acknowledged the potential benefits of the preliminary guidelines in supporting the harmonisation of objectives and processes between SESAR and EASA. In particular, while recognising that the two authorities have different mandates, it appreciates the value of collaboration from the early design stages, as promoted by the guidelines, and the importance of avoiding siloed approaches. EASA also recognises that initiating aligning early—especially in emerging areas such as AI—is a sound approach. Based on this, EASA confirmed its willingness to review the preliminary guidelines and recommended improving alignment with current industrial certification practices for both airborne and ground systems.
Deep Blue	Positive	The consulted experts provided positive feedback, particularly appreciating that the topic of certification was addressed contextually, within the existing SESAR subprocesses. The preliminary guidelines allow for the consolidation and reinforcement of existing know-how within the SESAR community, while maintaining sufficient flexibility to support exploratory research alongside compliance considerations.

Table 9. OBJ-HUCAN-TRL2-TVAL.02 Results - Detailed overview

4.3 Confidence in validation results

4.3.1 Limitations of validation results

The HUCAN validation results offer valuable insights into the potential benefits of supporting certification alignment in R&I initiatives since the early stages of development. However, some limitations restrict the generalisation of these findings:

- **Limited number of participants and interactions:** Due to scheduling and availability constraints, the number of experts directly consulted for validation, as well as opportunities for discussion, were limited.

Overall, the validation confirms the feasibility of the HUCAN preliminary guidelines. Importantly, the limitations described above do not negatively impact the maturity assessment of the concept, given its current low maturity level—TRL2.

4.3.1.1 Quality of validation results

Validation results are primarily based on qualitative data. This includes the feedback, comments and suggestions collected over the course of online meetings, review of documents and e-mail exchanges that occurred in the interaction with the members of the EG.

Considering the role of the organisations involved in the EG, the expertise of the individuals participating, and their experience with the topics addressed, the results collected can be assessed as **medium** – reliable and relevant in relation to the project’s objectives and its final TRL.

4.3.1.2 Significance of validation results

Given the validation technique employed and the structure of the exercise, it is not possible to estimate the statistical significance of the collected data. Consequently, the considerations outlined in the previous paragraphs remain applicable.

5 Conclusions and recommendations

5.1 Conclusions

For the sake of clarity, this section consolidates the overall results obtained from the validation activities. Compared to the original SESAR template, this entails only minor deviations. Specifically, the findings related to Conclusions on SESAR solution maturity (5.1.1) and Conclusions on concept clarification (5.1.2) are presented in aggregated form within the general-level conclusions. As for the Conclusions on technical feasibility (5.1.3), within the scope of HUCAN these can only be outlined in preliminary terms and are summarised here in terms of applicability. The Conclusions on performance assessments (5.1.4) are not applicable.

Based on this and in light of the specific characteristics of the HUCAN project and the outcomes of the exchanges with the EG, it can be concluded that **Solution 0446 – Preliminary Guidelines to design ATM-related systems based on higher levels of automation has been successfully validated**. This conclusion is supported by the fact that, with respect to validation objective OBJ-HUCAN-TRL2-TVAL.00, as updated in this document, all consulted experts expressed a generally positive opinion.

As a general remark, there was a broad endorsement of the certification-aware design preliminary guidelines, recognising its potential not only to shorten the research and development timelines toward market readiness, but also to support a more informed approach to the implications stemming from the classification of automation and AI levels for the future certification of research outcomes.

Considering the nature of the solution and the targeted maturity level (TRL2), the validation is considered to have yielded an overall positive outcome.

In terms of their significance for concept clarification, these results are particularly valuable in demonstrating the feasibility of adopting a certification-aware design approach from the early stages of R&I initiatives. They also contribute to consolidating and reinforcing existing know-how within the SESAR community, while preserving sufficient flexibility to support exploratory research in parallel with compliance objectives.

In this context, it is advised that the rationale and methodology adopted for the gap analysis and the definition of the toolkit—currently focused primarily on the SESAR framework—be consolidated and potentially extended to contexts beyond SESAR.

5.2 Recommendations

The following sections set out the main recommendations for refining the initial guidelines developed within the HUCAN project, which complement the certification-aware approach to design and validation.

5.2.1 Recommendations for next phase

In potential future development phases of the solution, research should focus on consolidating the preliminary guidelines with the aim of progressing towards an applied validation. This would involve

practically using the guidance to concretely verify the added value they provide in facilitating the alignment and integration of current R&I and R&D subprocesses with the new certification requirements proposed for AA and AI. Further details on these directions are provided in the following paragraphs.

5.2.2 Recommendations on regulation and standardisation initiatives

It is recommended to closely monitor the evolution and consolidation of new elements introduced through the implementation of the guidance proposed by EASA, as well as by the EC, particularly in light of the ongoing work promoted under the Rule Making Task: RMT.0742 – *Artificial Intelligence Trustworthiness*. These developments are expected to play a key role in shaping the regulatory and certification landscape for AI-based systems in aviation.

In addition, it is advised to consider the contribution that international standardisation efforts, particularly those led by EUROCAE and ISO, can offer in supporting the achievement of certification objectives. Special attention should be paid to the ongoing work of EUROCAE WG-114, notably the upcoming **ED-324 – Process Standard for Development and Certification Approval of Aeronautical Products Implementing AI** (currently in draft, with a publication target date of 31/12/2025). Likewise, several ISO/IEC JTC 1/SC 42-related standards are of strategic relevance, including:

- **ISO/IEC 42001:2023 – AI Management System**
- **ISO/IEC 23894:2023 – Guidance on AI Risk Management**
- **ISO/IEC 23053:2022 – Framework for AI Systems Using Machine Learning**
- **ISO/IEC 42005:2025 – AI System Impact Assessment**

These emerging regulatory and standardisation frameworks can contribute significantly to further clarifying the references, objectives, and requirements necessary to support a certification-aware approach to design and validation. Maintaining alignment with such developments will help ensure that the approach remains robust, future-proof, and anchored in legal certainty and standardisation best practices.

From an internal perspective, SESAR has already launched a revision process of its validation methodologies, also in response to the specific challenges posed by AI-related features. In this regard, clear synergies can be identified between the work carried out within HUCAN and that developed under projects such as **AMPLE3 – SESAR3 ATM Master Planning and Monitoring** (GA ID 101114738) and **PEARL – Performance Estimation, Assessment, Reporting and Simulation** (GA ID 101114676). Monitoring the outcomes of these projects can help reinforce and further consolidate the preliminary guidelines developed by HUCAN. Conversely, the solutions and methods elaborated within HUCAN may provide valuable input for the operationalisation of results emerging from other initiatives, particularly in the context of promoting a certification-aware approach within SESAR.

5.2.3 Recommendations for future R&I activities

For SESAR Solution 0446, potential advancements include extending the toolkit's capabilities to better address the gaps identified within the SESAR framework. The approach was considered promising, although further refinements will be needed to fully address the scope of the EASA concept paper and the SESAR framework, in order to obtain a comprehensive view of both overlaps and gaps. Overlaps may offer opportunities for easier alignment and harmonization, while gaps will require careful analysis to identify

potential challenges. Moreover, the methodology adopted in D5.2, together with the supporting toolkit, proved to be both practical and effective in delivering concrete results and actionable recommendations.

Furthermore, the development of a dedicated, and possibly partially automated, tool to support the certification-aware design process represents a valuable next step to facilitate practical implementation and improve usability.

6 References

6.1 Applicable documents

This VALR complies with the requirements set out in the following documents:

[SESAR solution pack](#)

- [1] SESAR 3 JU, Project Handbook, Edition 02.00, 19 December 2024

[Validation](#)

- [2] SESAR 3 JU, Project Handbook, Edition 02.00, 19 December 2024

[Programme management](#)

- [3] 101114762, HUCAN, Grant Agreement, 17.05.2023
[4] SESAR 3 JU, Project Handbook, Edition 02.00, 19 December 2024

6.2 Reference documents

- [5] EC, Ethics and data protection (Guidance note), 5 July 2021
[6] EASA, Artificial Intelligence Roadmap 2.0 – Human-centric approach to AI in aviation, Version 2.0, March 2023
[7] EASA, EASA Concept Paper: Guidance for Level 1 & 2 machine learning applications. A deliverable of the EASA AI Roadmap, Issue 02, March 2024 [EASA 2024(a)]
[8] EASA, EASA AI Days – High level conference, Cologne, Germany, 2nd and 3rd July 2024 (Day 1 Presentations) [EASA, 2024(b)]
[9] HUCAN, Deliverable 1.1 – Data management plan, Edition 01.00, 30 November 2023
[10] HUCAN, Deliverable 1.2 – Exploratory research plan, Edition 02.00, 29 February 2024
[11] HUCAN, Deliverable 4.4 - Holistic approach to approval and certification of automated systems, Edition 01.00, 30 June 2025
[12] SESAR JU, Strategic Research and Innovation Agenda – Digital European Sky, Luxembourg, September 2020.