AW-Drones proposed standards – 2nd iteration (SORA)

D4.2

AW-Drones

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AW-Drones

Abstract

The AW-Drones project aims at harmonizing the European drone regulatory framework by supporting the rulemaking definition process via the application of the existing standards which are deemed pertinent to the UAS domain. This document presents the second iteration of results deriving from the assessment of standards considered potentially compliant to the criteria set by the Specific Operations Risk Assessment methodology (SORA), as recommended by the European Aviation Safety Agency (EASA) as Acceptable Means of Compliance (AMC) to Article 11 of EU Regulation 947/2019. For each SORA criterion, the assessment provides a list of standards offering at least a partial coverage, the gaps which prevent a complete coverage, and a list of recommendations to cover each gap for fully meeting the criterion.

Note: the first iteration of the AW-Drones assessment of standards for the U-Space is included as a separate document after the end of the SORA document.

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Executive Summary

The AW-Drones project aims at harmonizing the European drone regulatory framework by supporting the rulemaking definition process via the identification of existing standards which are deemed pertinent to the drone domain.
This document presents the results of the second iteration of the assessment of standards considered potentially compliant to the criteria set by the Specific Operations Risk Assessment methodology (SORA) in the European Aviation Safety Agency (EASA) Acceptable Means of Compliance (AMC) to Article 11 of EU Regulation 947/2019. For each SORA criterion, the assessment provides a list of standards offering at least a partial coverage, the gaps which prevent a complete coverage, and a list of recommendations to cover each gap and fully meet the criteria.

The full assessment of the standards was preceded by a data collection phase which entailed a preliminary mapping of the collected standards with the SORA. This led to the identification, for each criterion, of a set of standards potentially suitable to support compliance.
According to the assessment methodology defined by the project in Work Package 2, the assessment focused on the following cases:

- CASE 1: one or more standards that are potentially suitable to comply with a given criterion are identified;
- CASE 2: there is no standard fully covering a given criterion, thus a gap is identified.

Thus, for each SORA criterion and (in Part I) and U-Space service (in Part II), this document presents:

- A list of standards that are in part or fully covering the criterion, ranked by a global score obtained by assessing each standard.
- A list of gaps identifying aspects that are not adequately covered by existing standards. Gaps are also given a score.
- Recommendations about the preferred standards and suggested strategies to fill the identified gaps based on their score.

The assessment was carried out for all criteria stemming from the SORA methodology, including:

  - Ground Risk Mitigations
  - Tactical Mitigations Performance Requirements (TMPR)
  - Operational Safety Objectives
  - Adjacent Area/Airspace considerations

From the analysis carried out the following conclusions can be made:

- For most SORA criteria that are applicable to Specific Assurance and Integrity Level (SAIL) VI there is at least a partial coverage from existing standards. The absence of full coverage, or the fact that a standard may not ultimately be recommended derives from several reasons:
  - Standards often have a low maturity as they are still in a development phase
  - Standards are only covering part of what SORA requires
  - Standards have a limited scope (e.g. Maximum Take-off Mass (MTOM) less than 25kg, only rotorcraft, etc.)

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- Standards that were developed for manned aviation can be too demanding for the UAS sector and hardly applicable in practice

It is recommended that:

- The coverage identified in this document after the second iteration of project AW-Drones, is published by the project as the unique European Meta-Standard supporting the application of the SORA methodology for the specific category of operations.
- The European Commission, supported by EASA, brings the gaps identified in this study to the attention of the European UAS (Unmanned Aircraft System) Standard Coordination Group (EUSCG) to initiate actions to fill the gap.

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1 Introduction

1.1 Standards' assessment in the context of AW-Drones

The lack of clear standards is holding back the development of the drone-related business, both at a global level and in Europe. Several studies and surveys identify a reliable regulatory and standardization framework as a main potential booster for the drone business. Therefore, to foster the growth of a safe drone usage, there is a need to implement coherent and interoperable global standards and regulations for drones in the European Union (EU). The EU's Horizon 2020 Research and Innovation Program funded AW-Drones to tackle these issues and guide future EU drone regulation.
AW-Drones contributes to harmonize the European Union's (EU's) drone regulation and standards, supporting the rulemaking process for the definition of rules, technical standards and procedures for civilian drones to enable safe, environmentally sound and reliable operations in the European Union. In order to achieve this, one of the sub-goals of the project is to propose a well-reasoned set of technical standards for operations, appropriate for all relevant categories of drones.
A work plan has been formulated to collect and assess existing and planned standards. The effort is split into three main technical work packages (WP):

- WP2 - Development of a methodology for categorization and assessment
- WP3 - Collection and categorization of standards that might be applicable for UAS
- WP4 - Assessment of these standards to evaluate their feasibility to support this process in order to derive a set of standards that are validated and found applicable.

While the first activity was carried out only at the beginning of the project to set the ground for all the subsequent work, both the data collection and the assessment of the standards is carried out iteratively over the course of the three years of the project. In particular during the first year (2019) the project focused on the collection and assessment of standards potentially suitable to support the demonstration of compliance to the criteria in the Specific Operations Risk Assessment methodology (SORA). The SORA methodology is officially published by EASA as Acceptable Means of Compliance (AMC) to Article 11 of EU Regulation 947/2019 [1] but currently lacks guidance on which technical standards the drone operators could use. The second iteration of the project focuses on integrating the first iteration's work on standards applicable to the SORA methodology, while including an assessment of standards deemed applicable to the identified U-space services.
This document provides the results of the aforementioned assessment. In line with the iterative approach of the AW-Drones project, this deliverable provides the second iteration results of a living document that was updated regularly during the project to include updates related to the standards assessed and inputs from relevant UAS industry stakeholders (e.g. EASA, Standard Making Bodies, Operators, etc.).
We acknowledge that the amount of information contained in this document might affect its readability. For this reason, the AW-Drones project has developed an online repository (alias "metastandard") where the same information is accessible in an easier way allowing consultation to any user. Authorized users, such as EASA and the standard design organizations (SDO) have the privilege to comment the content of the repository and propose updates and changes.

1.2 Purpose and scope of this document

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As reported in the section above, the full assessment of the standards was preceded by a data collection phase which entailed a preliminary mapping of the collected standards with SORA criteria. This led to the identification of a set of standards potentially suitable to support compliance.
According to the assessment methodology defined in [2], the assessment that is presented in this document is focused on the following cases:

- CASE 1: one or more standards that are potentially suitable to comply with a given criterion/service have been identified;
- CASE 2: there is no standard fully covering a given criterion/service, thus a gap is identified.

For each SORA objective and mitigation (in Part I) and U-Space service (in Part II) this document will therefore present:

- A list of standards that are covering it in part or fully, ranked by a global score obtained by assessing each standard according to the methodology described in [2].
- A list of gaps identifying aspects that are not adequately covered by existing standards. Gaps are also given a score based on the criteria listed in [2].
- Recommendations about the preferred standards and suggested strategies to fill the identified gaps based on their score.

The aforementioned assessment was carried out for all criteria stemming from the SORA methodology:

- Ground Risk Mitigations
- Tactical Mitigations Performance Requirements (TMPR)
- Operational Safety Objectives
- Adjacent Area/Airspace consideration.

With respect to the standards considered in the analysis, the scope was limited considering the following aspects:

- Standards that were still in planning phase were not considered, except when the first draft was already available.
- The maturity of the standards is updated to the last assessment conducted. This may have or may change by the next iteration of the project.
- AW-Drones partners did not have full access to all standards at the time of the assessment. A complete assessment is provided only for the standards with full access. For the others we provide a preliminary assessment based on the publicly available information. [1]

Moreover, OSO #4 – 'UAS developed to authority recognized design standards' is not addressed because a more comprehensive analysis is needed in coordination with EASA.
It shall be emphasized that the assessment did not address the technical quality of the individual standards. It was assumed that each standard was adequate to fulfil the scope for which it was developed, and hence the assessment only evaluated the standard's capability to address the criteria.

[1] To cope with this issue the AW-Drones project is working to establish agreements with the main Standard Making Bodies (e.g. ASTM, EUROCAE, SAE) to obtain access to their standards for the exclusive purpose of the assessment.

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1.3 Structure of the document

This document has five sections:

- Section 1 provides an introduction, defines the scope of the document, and presents its structure.
- Section 2 provides an overview of the results related to the assessment of technical standards for their effectiveness to fulfil SORA criteria. The results are presented in a synthetic way to show the coverage of SORA criteria at each level of robustness. Where the coverage is not full, gaps are identified and briefly summarised.
- Section 3 contains a detailed overview of the assessment. For each SORA criterion the following information is provided:
    - The description of the criterion as it was published in the AMC & GM to Commission Implementing Regulation (EU) 2019/947 [1];
    - A list of standards that could be used to fulfil the criterion with their overall score that take into account the maturity, type of standard, effectiveness to fulfil the criterion, cost of compliance, environmental impact and impact on EU industry competitiveness. For details regarding the assessment methodology, the reader should refer to the AW-Drones Annex with the individual standards' assessments Excel document.
    - A list of gaps identified where there are no standards fully covering the whole criterion. Gaps are also evaluated in terms of different criteria to rank them and help identify the priorities and possible recommendations.
- Section 4 provides the conclusions and highlights the main recommendations that stem from the analysis presented in Section 3.
- Annex 1 includes the detailed assessment of each individual standard that has been taken into account as potentially suitable to meet the SORA criteria. In this Annex the reader will find the rationale behind the global score assigned to each standard.

1.4 How to Read This Document

This section highlights the main features of the tables describing the assessment of each standard, as outlined in Section 3 'Detailed Results'. It explains how the information is presented and how to effectively read the results presented.

The figures below are taken as representative examples in portraying how each SORA criterion evaluates the extent of coverage and possible gaps arisen from the assessment of standards considered, where the following guideline applies:

- A white cell indicates that a standard is required;
- Grey shading indicates that a standard is not required.

1.4.1 Requirement description table

Each sub-section under Section 3 starts with a table with the criteria as defined in [1]. The table below provides an example of what these tables look like.

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Criteria	Robustness	Description
Criterion 1	Low	• The UAS maintenance instructions are defined and when applicable cover the UAS designer instructions and requirements. • The maintenance staff is competent and has received an authorisation to carry out UAS maintenance • The maintenance staff use the UAS maintenance instructions while performing maintenance.
	Medium	Same as Low. In addition: • Scheduled maintenance of each UAS is organised and in accordance with a Maintenance Programme. • Upon completion, the maintenance log system is used to record all maintenance conducted on the UAS including releases. A maintenance release can only be accomplished by a staff member who has received a maintenance release authorization for that particular UAS model/family.
	High	Same as Medium. In addition, • the maintenance staff works in accordance with a maintenance procedure manual that provides information and procedures relevant to the maintenance facility, records, maintenance instructions, release, tools, material, components, defect, deferral…

Figure 1 Criterion description example

A Criterion Description table provides a detailed description of the safety criterion to be met for a SORA objective or mitigation. The columns are divided as follows:

Criterion

Each SORA objective or mitigation has to meet one or more criteria. The column 'criterion' numbers these criteria for each objective or mitigation. In case there is more than one criterion, all criteria have to be fulfilled.

Robustness

Lists the applicable levels of robustness with which the specific objective or mitigation shall be implemented in order to meet a specific SAIL level. The level of robustness is computed by combining the level of robustness for the level of Integrity (the safety gain deriving from the application of the mitigation) and the level robustness for the level of Assurance (the method of proof used to demonstrate that the safety gain has been achieved).

For the Operational Safety Objectives (OSO), the criteria for which a standard is not required are highlighted in grey, while those for which a standard would be needed are white.

Description

The actual description of the criteria as extracted from the relevant SORA Annexes.

1.4.1 Summary of standards assessed for a given criterion

The table summarises the list of standards that could be used to fulfil the criterion with their related level of effectiveness to fulfil the criterion. The columns are divided as follows:

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Standard Title	SDO	Doc. Reference	Robustness Criterion 1		
			L	M	H
Integrity					
New Specification for Operation over People	ASTM	WK52089		P	P
Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)	ASTM	F3178-16		P	P
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	P	P	P
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	P
Assurance					
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P
Standard Practice for Independent Audit Program for Unmanned Aircraft Operators	ASTM	F3364-19		P	P
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P	P

Figure 2 Example of a standards' effectiveness in fulfilling a SORA criterion

Standard title, SDO, Doc. Reference

Provide the title of the standard, the standard-making body, and the relevant document reference.

Robustness

For each criterion, 'robustness' indicates the effectiveness of the standard to fulfil the SORA criterion, for the levels Low, Medium and High. In this area P means that the coverage is Partial and F that the coverage is Full. If the cell is blank it means that the standard does not cover the criterion. A grey cell means that a standard is not required.

The consortium assessed standards that are available for free; standards that need to be purchased were only included if already available to one of the consortium partners, else this was done only on basis of the summary of the standard, when available. Standards that were still under development could only be assessed on basis of their Terms of Reference or their Statement of Work. The scores of these assessments could therefore only be based on expectations, which is indicated by placing these scores between brackets, i.e. '(P)' and '(F)', respectively indicating a potential partial or full coverage.

1.4.2 Coverage detail

The Coverage Detail table gives additional information regarding the standard's evaluation, along with the gaps identified for each standard in fulfilling a given criterion. Gaps might be present even if a standard has a full coverage simply because their scope might not cover the full range of UAS designs (e.g. standard only for Fixed Wing UAS).

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	P	The standard provides high-level guidance.
Notes: This document specifies the requirements for safe commercial UAS operations. With respect to the UAS Operator, this standard provides a list of the documents that an operator shall prepare to demonstrate that he is competent and/or proven (i.e. OSO #1 requirements). However, it does not contain detailed guidance on how to prepare such documents. It is expected that ISO standards will refer to other SDO's standards for guidelines on how to develop specific items. Nevertheless, an operator that is certified according to this ISO standard by an ISO notified body, can certainly claim to fulfil OSO #1 at all levels of robustness.						

Figure 3 Coverage detail example

1.4.3 Gap summary

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A gap summary table highlights the identified gaps missing to fully cover the criterion. The columns are divided as follows:

Gap	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Absence of standards covering: The remote crew ensures the UAS is in a condition for safe operation and conforms to the approved concept of operations	-7	It is recommended to develop a standard to ensure that the condition of the UAS conforms to the approved concept of operations.
2	Absence of standards covering: Product inspection is documented and accounts for the manufacturer's recommendations	-7	It is recommended to develop a standard for documentation of what needs to be inspected prior to a flight.
3	Absence of standards covering: The remote crew's is trained to perform the product inspection, and that training is self-declared (with evidence available).	-7	It is recommended to develop a standard for training for what needs to be inspected prior to a flight.
4	Absence of standards covering: Product inspection is documented and accounts for the manufacturer's recommendations if available. In addition, the product inspection is documented using	-7	It is recommended to develop a standard for checklists of what needs to be inspected prior to a flight.

Figure 4 Gap summary example

Gaps and Gap Description

Provides a number for each gap identified, explaining the nature of the gap and its rationale. The gaps listed in this table are generally not the same as those identified in the assessment of the individual standards, but rather a combination of them.

Total Weighted Gap Score

Provides the total score weighed against specific criteria, as listed in Gap Details. A negative sign indicates that the gap is somehow critical and actions might be required to fill the gap, whereas a positive sign indicates that the need to develop additional guidance/standard is not evident.

Conclusion and Recommendations

It provides conclusions on gaps which have arisen, with recommendations in relation to the severity of each respective score.

1.4.1 Gap details

A Gap Details table evaluates each gap on the basis of the criteria defined in [2] which are: safety, cost of compliance to the criterion by a lack of standards, environmental impact, impact on EU industry competitiveness, social acceptance. The columns are divided as follows:

Criteria (Weight)

Each criterion has a weight that is related to its relevance. For example, safety, being of paramount importance, holds the highest impact on the evaluation and hence has the highest weight. The weight is given between brackets.

Result

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Low to high impact of the gap on the criterion (see [2] for a detailed description of the assessment methodology).

Rationale

Reasoning behind a result (see previous).

Score

This column numerically quantifies the "result" in order for it to be successively weighed against the weight of each criterion.

Weighted Gap Score

The final weighted score is given by the multiplication of score x weight, enabling the analysis via an element of comparison between each identified gap.

Gap	Gap Description	Criteria (Weight)	Result	Rationale	Score	Weighted Score
1	Absence of standards covering The remote crew ensures the UAS is in a condition for safe operation and conforms to the approved concept of operations	Safety (3)	High	The lack of standards to ensure that the condition of the UAS conforms to the approved concept of operations requires the remote crew to develop a method and get it approved. This could result in certain inspection items being overlooked by the remote crew or authorities. This could result in undetected technical failures which could potentially be safety critical.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standards to ensure that the condition of the UAS conforms to the approved concept of operations requires the remote crew to develop a method and get it approved.	0	0
		Environmental Impact (1)	Bad	An undetected inadequate condition of battery systems prior to flight could cause the UAS to crash and cause fires.	-2	-2
		Impact on EU Industry competitiveness (1)	Negative	There is a cost of compliance for remote pilots, a required effort by aviation authorities, and consequently also a negative impact on commercial use of UAS in the EU market.	-1	-1
		Social Acceptance (1)	Negative	The lack of standards to ensure that the condition of the UAS conforms to the approved concept of operations may give for social acceptance of UAS flights a negative feed-back on the competence of the remote crew People are used to see the pilot checking an aircraft before flight.	-1	-1
Total Weighted Score						-7

Figure 5 Gap details example

1.4.1 Conclusions and Recommendations

The final section gives an overview of the current coverage of each criterion, providing a table with the best identified standards that cover the criterion at present, alongside any associated limitations and gaps.

Furthermore, a score is provided for each recommended standard associated to the specific level of integrity/assurance of the criterion it covers. Each individual score is evaluated as per Annex 1 Standards' assessment multi-criteria analysis. This document contains an assessment of each individual standard, alongside the rationale behind each score. The greater the score, the easier it will be for UAS operators to actually use the standard. For details on the assessment methodology refer to [2], for details on how the global score has been computed for each standard refer to Annex 1.

1.5 List of Acronyms

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Acronym	Description
AESA	Spanish Aviation Safety and Security Agency
AMC	Acceptable Means of Compliance
ARC	Air Risk Class
ASTM	ASTM International
ATC	Air Traffic Control
BVLOS	Beyond Visual Line of Sight
C2	Command and Control Link
C3	Command, Control and Communication
CAA	Civil Aviation Authority
CERTH	Centre for Research & Technology Hellas
ConOps	Concept of Operations
DAA	Detect and Avoid
DJI	DJI Europe B.V
DLR	German Aerospace Centre
DoD	Department of Defence
EASA	European Union Aviation Safety Agency
ERP	Emergency Response Plan
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
EVLOS	Extended Visual Line of Sight
FAA	Federal Aviation Administration
FCU	Flight Control Unit
FSF-MED	Flight Safety Foundation – SE Europe
GM	Guidance Material
GPS	Global Positioning Unit
GRC	Ground Risk Class
HMI	Human Machine Interface
HW	Hardware
IAI	Israel Aerospace Industries Ltd.
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
JARUS	Joint Authorities for Rulemaking of Unmanned Systems
MTOM	Maximum Take-Off Mass
NATO	North Atlantic Treaty Organization
NFPA	National Fire Protection Association
NLR	Netherlands Aerospace Centre
OSO	Operational Safety Objective
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RTCA	Radio Technical Commission for Aeronautics
RTH	Return-to-Home
SAE	Society of Automotive Engineers
SAIL	Safety Assurance and Integrity Level
SDO	Standard Design Organization

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SORA	Specific Operations Risk Assessment
STANAG	Standardization Agreement
STD	Standard
SW	Software
TMPR	Tactical Mitigations Performance Requirements
TU Delft	Delft University of Technology
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
US	United States
VLOS	Visual Line of Sight
WG	Working Group

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2 Summary of Results - SORA

This section presents a summary of the results of the assessment and gives an overview of the general coverage of all SORA requirements. For details on the individual assessment of each requirement, refer to Section 3.

2.1 Criteria coverage overview

SORA is an AMC, as well as a tailoring guide that allows a UAS operator to find a best fit mitigation means, and hence reduce the risk to an acceptable level. For this reason, it does not contain prescriptive requirements, but rather safety objectives to be met at various levels of robustness, commensurate with the risk.

In this report the term 'requirement' is used to indicate a means to comply with a mitigation or objective in the SORA, and hence is not mandatory.

The tables below highlight the degree to which each SORA criterion (i.e. mitigation or objective) is covered in the current regulatory framework, providing a score that is generated considering the standard maturity, type of standard, effectiveness to fulfil the SORA 'requirement', cost of compliance, environmental impact, impact on EU industry competitiveness. The scores are colour-coded as follows:

- Green shading indicates that the proposed standard is adequate to be recommended according to the AW-Drones assessment (i.e. score => 10) .
- Yellow shading indicates the proposed standard is potentially suitable to be recommended but there exist gaps and constraints (e.g. high cost for implementation, low maturity) that does not allow to recommend them immediately (i.e. 0 < score < 10).
- Grey shading indicates that a standard is not required.
- Red shading indicates that the criterion is not currently covered by any standard.

Table 1

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M1 - Integrity	*Non-tethered operation* - Criterion #1 (Definition of Ground Risk Buffer)	Low Medium High	Partial	ENAC-LG 2017/001-NAV - Methodology for the UAS Operational Risk for non-geographical flight permits Appendix A – "RPA casualty area determination" and Appendix B – "Probabilistic criteria for the buffer determination	5

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			Partial	DGAC AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4 - §18.3.- « Protection des tiers au sol » (« uninvolved people on ground protection »)	5
			Partial	EUROCAE ED-270 Geocaging Appendix 1	4
	Non-tethered operation - Criterion #2 (Evaluation of people at risk)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	DGAC AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4 - §18.3.-« Protection des tiers au sol » (« uninvolved people on ground protection »)	1
		High	N.A.	NO STANDARD AVAILABLE	N.A.
	Tethered operation - Criterion #1 technical design	Low	N.A.	NO STANDARD REQUIRED	
		Medium	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	N.A.
			Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	4
		High	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	N.A.
	Tethered operation - Criterion #2 procedures	Low	N.A.	NO STANDARD REQUIRED	
		Medium High	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	4
			Full	ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	10

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Table 2

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M1 - Assurance	*Non-tethered operation* - Criterion #1 (Definition of the ground risk buffer)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	N.A.	NO STANDARD REQUIRED	
		Medium	N.A.	NO STANDARD REQUIRED	
	Non-tethered operation - Criterion #2 (Evaluation of people at risk)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	DGAC - AÉRONEFS CIRCULANT SANS PERSONNE A BORD: ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	1
		High	N.A.	NO STANDARD AVAILABLE	N.A.
	Tethered operation - Criterion #1 technical design	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	4
		Medium High	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	N.A.
	Tethered operation - Criterion #2 procedures	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	4
		Medium High	Full	ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	10

Table 3

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score

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M2 - Integrity	Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	F3322-18: Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	4
		High	Partial		
	Criterion #2 (Procedures, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE	N.A.
	Criterion #3 (Training, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE	N.A.

Table 4

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M2 - Assurance	Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	F3322-18: Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	4
		High	Partial		
	Criterion #2 (Procedures, if applicable)	Low	N/A	NO STANDARD REQUIRED	
		Medium	N/A	NO STANDARDS AVAILABLE	N.A.
		High			
	Criterion #3 (Training, if applicable)	Low	N/A	NO STANDARD REQUIRED	
		Medium High	N/A	NO STANDARD AVAILABLE	N.A.

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Table 5

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M3 - Integrity	Integrity Criterion	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3: Operational Procedures	2
		High	Partial	ISO 21384-3: Operational Procedures	4
				IATA Emergency Response Plan	2

Table 6

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M3 - Assurance	Assurance Criterion #1 (Procedures)	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3: Operational Procedures	2
		High	Partial	ISO 21384-3: Operational Procedures	4
	Assurance Criterion #2 (Training)	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	ISO 23665 Unmanned aircraft systems -Training for personnel involved in UAS operations	2
		High	Partial		

Table 7

Mitigation	Criterion	Coverage	Recommended standard	Score
Tactical Mitigations - VLOS	Criterion #1 (De-confliction scheme)	N/A	NO STANDARD AVAILABLE	N.A.
	Criterion #2 (Phraseology, procedures and protocols)	Partial	ASTM F1583-95 (2919): Standard practice for communications procedures - phonetics	6

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Table 8

Mitigation	Functions	Arc	Coverage	Recommended standard	Score
TMPR - BVLOS	All	Arc-a	N/A	NO STANDARDS REQUIRED	
		Arc-b	Partial	F3442 - Detect and Avoid performance Requirements	6
				DO-289 Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	3
				ED 258 Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR	5
				ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	8
		Arc-c	Partial	F3442 - Detect and Avoid performance Requirements	6
				DO-289 Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	3
				ED 258 Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR	5
				ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	8
		Arc-d	Partial	DO-365: MOPS for Detect and Avoid (DAA) Systems-Phase 1	2
				ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	8
				ED-271: MASPS for Detect & Avoid [Traffic] in Class A-C airspaces under IFR	2
				DO-366 Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance	3

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				ED-265 Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)	4

Table 9

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 01 - Integrity	Criterion #1	Low	Partial	ISO 21384-3: Operational Procedures	2
		Medium High	Partial	ASTM F3178-16: Standard practice for operational risk assessment of small unmanned aircraft systems (sUAS	3
			Partial	ISO 21384-3: Operational Procedures	4

Table 10

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 01 - Assurance	Criterion #1	Low	N/A	NO STANDARD REQUIRED	
		Medium High	Partial	ISO 21384-3: Operational Procedures	4
			Partial	ASTM F3364-19*: Standard practice for independent audit program for unmanned aircraft operators	4

Table 11

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 02 – Integrity/Assurance	Criterion #1	Low Medium	Partial	ASTM F3003-14: Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	11 (low) 13 (med)

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				ASTM F2911-14e1 Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)	5 (low)
			Full	EN 9100:2018: Quality Management Systems – Requirements for Aviation, Space and Defence Organizations	9 (low) 11 (med)
				ASTM F2972-15: Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System	5 (low) 7 (med)
				ISO 9001:2015 Quality management systems – Requirements	10 (low) 12 (med)
		High	Partial	ASTM F3003-14 - Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	9
			Full	ISO 9001:2015 Quality management systems – Requirements	14
				EN 9100:2018 Quality Management Systems - Requirements for Aviation, Space and Defence Organizations	11

Table 12

Objective	Criterion	Robustness	Coverage	Recommended standard	Score

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OSO 03 - Integrity	Criterion 1	Low	Full	NO STANDARD REQUIRED	
		Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	11
			Full	ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	10
			Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	9
			Partial	ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)	4
		High	Full	S4000P - International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	13
				JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	11
				MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	9

Table 13

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 03 - Assurance	Criterion 1	Low	Full	NO STANDARD REQUIRED	
		Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	11

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			Full	ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	10
			Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	9
			Partial	ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)	4
		High	Full	S4000P - International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	13
				JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	11
				MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	9
	Criterion 2 (Training)	Low	N/A	NO STANDARD REQUIRED	
		Medium	N/A	NO STANDARD REQUIRED – ISO 23665 may be used as guidance	10
		High	Full	NCATT – Unmanned Aircraft System (UAS) Maintenance Standard	12
				WK60659 - UAS Maintenance Technician Qualification	6

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Table 14

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 05 - Integrity	Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	12
				EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS	13
		Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	9
		High	Partial	EUROCAE ED-79A Guidelines for Development of Civil Aircraft and Systems	8
				EUROCAE /RTCA ED-12/DO-178 Software Considerations in Airborne Systems and Equipment Certification	8
				EUROCAE /RTCA ED-80/DO-254 Design Assurance Guidance for Airborne Electronic Hardware	8

Table 15

	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 05 - Assurance	Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	12
				EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS	13
		Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	9
			Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft	4

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			Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	6
			Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	4
		High	Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft	4
			Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	6
			Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	6

Table 16

	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 06 - Integrity	Criterion #1	Low	N/A	NO STANDARDS REQUIRED – The standards applicable to Medium Robustness are applicable also for a Low level of Robustness for guidance.	
		Medium	Partial	ASTM F3002 – 14 - Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	6
			Partial	IEEE 802.11, IEEE 802.11a – WIFI technology (2.4 GHz + 5 GHz Band)	6
			Partial	IEEE 802.15.1 – Bluetooth technology	6
			Partial	IEEE 802.22 - Wireless regional area network (WRAN)	6
			Partial	3GPP - TR 36.777 Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles	6

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			Partial	EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS	2
		High	Partial	EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS	4
			Partial	RTCA DO-362 - Command and Control (C2) Data Link Minimum Operational Performance Standard (MOPS) (Terrestrial)	4
			Partial	EUROCAE ED-265 - Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)	2

Table 17

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 06 - Assurance	Criterion #1	Low	N.A.	NO STANDARD REQUIRED	
		Medium	(Partial)	ASTM WK58930: New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control – this document was unavailable	N.A.
		High	(Partial)	ASTM WK58930: New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control – this document was unavailable	N.A.

Table 18

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 07 - Integrity	Criterion #1	Low	Full	ISO 21384-3: Operational Procedures	12
		Medium	Full	ISO 21384-3: Operational Procedures	12
		High	Full	ISO 21384-3: Operational Procedures	12

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Table 19

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 07 - Assurance	Criterion #1	Low	Partial	ISO 23665 – Training for personnel involved in UAS operations	0
		Medium	Partial	ISO 21384-3: Operational Procedures	6
				ISO 23665 – Training for personnel involved in UAS operations	2
		High	Partial	ISO 21384-3: Operational Procedures	4
				ISO 23665 – Training for personnel involved in UAS operations	4

Table 20

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 08, 11, 14, 21 - Integrity	Criterion #1 (Procedure definition)	Low/Medium/High	Partial	ISO 21384-3: Operational Procedures	8
	Criterion #2 (Procedure complexity)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	N.A.	NO STANDARD REQUIRED	
		High	N.A.	NO STANDARD REQUIRED	
	Criterion #3 (Consideration of Potential Human Error)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3: Operational Procedures	2
		High	Partial		

Table 21

Objective	Criterion	Robustness	Coverage	Recommended standard	Score

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OSO 08, 11, 14, 21 - Assurance	Criterion	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3: Operational Procedures	2
		High	Full		

Table 22

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 09, 15, 22 - Integrity	Criterion #1	Low Medium High	Partial	JARUS Recommendations for RPC	8
				ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	4

Table 23

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 09, 15, 22 - Assurance	Criterion #1	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	JARUS Recommendations for RPC	8
				ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	4
				ASTM F3330-18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	4
		High	Partial	JARUS Recommendations for RPC	8
				ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	4
				ASTM F3330-18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	6

Table 24

Objective	Criterion	Robustness	Coverage	Recommended standard	Score

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OSO 10, 12 – Integrity/Assurance	Criterion 1	Low	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	6
				F3230-17: Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft	4
		Medium	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	8
		High	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	8
				ED-79A/ARP4754A: Guidelines for Development of Civil Aircraft and Systems	6
				ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	6

Table 25

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 13 - Integrity	Criterion	Low Medium High	Partial	ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures	2
				ISO 21384-2 - Unmanned aircraft systems -- Part 2: Product systems	2

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				16803-1:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part1- Definitions and system engineering procedures for the establishment and assessment of performance	3
				16803-2:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals	1
				Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.	8
				Guidelines for the use of multi-GNSS solutions for UAS	3
				ISO 23629-12 - Requirements for UTM services and service providers	2

Table 26

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 13 - Assurance	Criterion	Low			
		Medium High	Partial	ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures	2
				ISO 23629-12 - Requirements for UTM services and service providers	2

Table 27

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 16 – Integrity/Assurance	Criterion #1 Procedures	Low	N.A.	NO STANDARD REQUIRED	

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		Medium		NO STANDARD AVAILABLE	N.A.
		High		NO STANDARD AVAILABLE	N.A.
	Criterion #2 Training	Low	N.A.	NO STANDARD REQUIRED	
		Medium		NO STANDARD AVAILABLE	N.A.
		High		NO STANDARD AVAILABLE	N.A.
	Criterion #3 Communication devices	Low	N.A.	NO STANDARD REQUIRED	
		Medium		NO STANDARD AVAILABLE	N.A.
		High		NO STANDARD AVAILABLE	N.A.

Table 28

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 17 – Integrity/Assurance	Criterion	Low		NO STANDARD REQUIRED	
		Medium		NO STANDARD REQUIRED	
		High		NO STANDARD AVAILABLE	N.A.

Table 29

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 18 – Integrity/Assurance	Criterion #1	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	STANAG 4671 – UAV System Airworthiness Requirements (USA)	1
			Partial	STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements	1
			Partial	JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	1

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			Partial	JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	1
		High	Partial	STANAG 4671 – UAV System Airworthiness Requirements (USA)	3
			Partial	STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements	3
			Partial	JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	3
			Partial	JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	3

Table 30

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 19	Criterion #1 (Procedures and checklists)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3 UAS – Part 3: Operational Procedures	2
		High		ISO 21384-3 UAS – Part 3: Operational Procedures	4
	Criterion #2 (Training)	Low (integrity only)	Partial	JARUS Recommendations for RPC	7
				ASTM F3266-18	4
				ASTM F3379-20	4
				ASTM F3330 – 18	2
				ISO 23665	0
		Medium (Integrity and Assurance)		JARUS Recommendations for RPC	7
				ASTM F3266-18	6

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				ASTM F3379-20	4
				ASTM F3330 – 18	4
				ARP5707	4
				ISO 23665	2
				ASTM WK62741	0
		High (Integrity and Assurance)		JARUS Recommendations for RPC	7
				ARP5707	6
				ASTM F3330 – 18	6
				ISO 23665	4
				ASTM WK62741	2
	Criterion #3 (UAS design)	Low	N.A.	NO STANDARD AVAILABLE	N.A.
		Medium	N.A.	NO STANDARD AVAILABLE	N.A.
		High	N.A.	NO STANDARD AVAILABLE	N.A.

Table 31

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 19 - Assurance	Criterion #2	Low	Covered above, together with Integrity.		
		Medium			

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	(Training)	High	Full	Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	For high robustness assurance, the JARUS GM covers fully how a RAE is defined and what are its tasks in relation to the entities it audits.	12

Table 32

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 20 – Integrity	Criterion #1	Low	Partial	UAV System Airworthiness Requirements (USAR) - UAS GCS Human systems Integration (HSI) Guidance and Human Factors (HF) Airworthiness considerations (based on STANAG 4671) – DRDC	1
			Partial	STANAG 4703	1
		Medium	Partial	UAV System Airworthiness Requirements (USAR) - UAS GCS Human systems Integration (HSI) Guidance and Human Factors (HF) Airworthiness considerations (based on STANAG 4671) – DRDC	3
			Partial	STANAG 4703	3
		High	Partial	UAV System Airworthiness Requirements (USAR) - UAS GCS Human systems Integration (HSI) Guidance and Human Factors (HF) Airworthiness considerations (based on STANAG 4671) – DRDC	5
			Partial	STANAG 4703	5

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Table 33

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 20 – Assurance	Criterion #1	Low	Partial	SESAR Human Performance Assessment (HPA)	2
		Medium	Partial	SESAR Human Performance Assessment (HPA)	4
		High	Partial	SESAR Human Performance Assessment (HPA) SESAR Human Performance Assessment (HPA)	4

Table 34

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 23 – Integrity/Assurance	Criterion #1 – [Definition]	Low	N.A.	NO STANDARD REQUIRED	
		Medium		NO STANDARD AVAILABLE	N.A.
		High		NO STANDARD AVAILABLE	N.A.
	Criterion #2 [Procedures]	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures	2
		High		NO STANDARD AVAILABLE	N.A.
	Criterion #3 [Training]	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Full (Assurance)	Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	13
			Partial	DOC - 1009 - Manual on Remotely Piloted Aircraft Systems (PSURs)	7

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				F3330 – 18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	6
				ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	3
				ARP 5707	4
		High	Partial	ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	4
				ARP5707	4

Table 35

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 24 – Integrity/Assurance	Criterion #1	Low	N/A	NO STANDARD REQUIRED	
		Medium	FULL, BUT NO STANDARD REQUIRED. THE FOLLOWING CAN BE USED AS GUIDANCE	UL 3030 – “Standard for Unmanned Aircraft Systems”	12
				IEC 60529 – “Degrees of protection provided by enclosures (IP Code)”	10
				ASTM F3298-19 – “Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems”	8

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				EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"	8
				JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"	7
				JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"	7
			Partial	EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"	2
				NATO STANAG 4671 – "UAV System Airworthiness Requirements (USAR)"	1
				NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"	1
				NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"	1

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				UL 3030 – "Standard for Unmanned Aircraft Systems"	8
				IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	6
				ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"	4
		High	Partial	EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"	4
				NATO STANAG 4671 – "UAV System Airworthiness Requirements (USAR)"	3
				NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"	3
				NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"	3

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				JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"	3
				JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"	3
				EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"	3

Table 36

Objective	Criterion	Requirement	Coverage	Recommended standard	Score
Adjacent Airspace/Area	Criterion #1	All	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	13
	Criterion #2	1	Full	EUROCAE ED-270 MOPS Geocaging	13
			Full	EUROCAE ED-269 MOPS Geofencing	13
		2	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	11
				ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	12

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				SAE ARP4761A Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	10
		3	Partial	RTCA/EUROCAE DO-254/ED-80 Design Assurance Guidance for Airborne Electronic Hardware	6
			Partial	EUROCAE/RTCA ED 12/DO-178 Software Considerations in Airborne Systems and Equipment Certification	6
			(Partial)	EUROCAE WG-117 Software Considerations in Lower Risk Applications, Equipment Certifications and Approvals	N.A.

2.2 Overview of identified gaps

The following tables provide an overview of the gaps to fully cover each SORA criterion, with their weighted score. The case may arise in which multiple standards providing a partial coverage to the criterion jointly provide full coverage, hence yielding no gaps.

The gaps have been classified into three categories, to better highlight their nature:

- Procedures: Gaps that refer to specific instructions and protocols associated with UAS operations.
- Technical: Gaps that to standards related to the design of the UAS, any of its components and/or external services.
- Training: Gaps that refer to guidelines on how to conduct training and structure training material for personnel involved in UAS operations.

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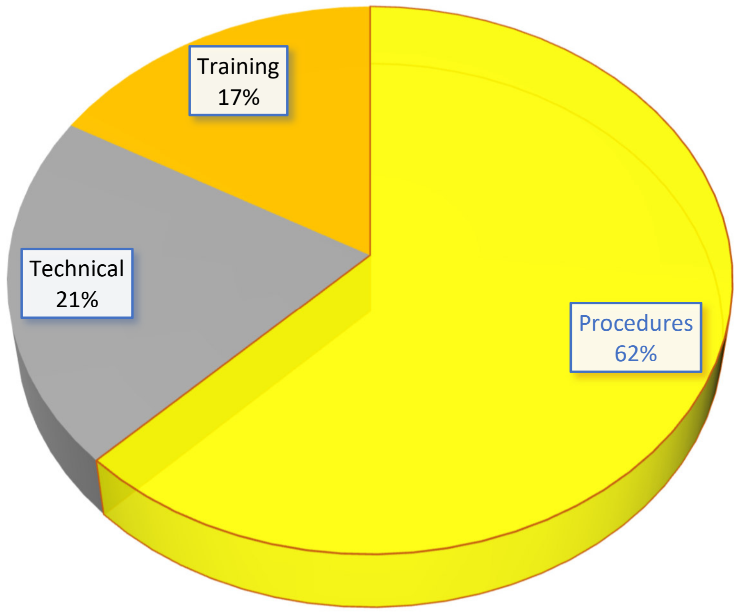

Figure 6 Overview of gaps identified

Table 37 Strategic Mitigations for Ground Risk: Gap Overview

Mitigation	Gap	Classification	Score
M1	No harmonised standard/guideline available for the definition of the ground risk buffer	Procedures	-5

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	No standard defining how to evaluate number of people at risk. More specifically absence of specific standard/guidance defining: • how to evaluate the area of operations by means of on-site inspections/appraisals to justify lowering the density of people at risk • what can be sheltered environment • what can be authoritative density data (e.g. data from UTM data service provider) relevant for the proposed area and time of operation to substantiate a lower density of people at risk. • what can be average density map for the date/time of the operation from a static sourcing (e.g. census data for night time ops). • how can be defined for localised operations (e.g. intra-city delivery or infrastructure inspection) the proposed route/area of operation to the applicable authority (e.g. city police, office of civil protection, infrastructure owner etc.) what can be near-real time density map from a dynamic sourcing (e.g. cellular user data) and applicable for the date/time of the operation.	Procedures	-6
	Absence of standards for the mechanical characteristics of the line	Technical	-6
	No specific standard defining how to define installation and maintenance procedures of tether	Procedures	-5
M2	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required.	Procedures	-6
	No standards for contingency or emergency procedures containing means of reduction of ground impact	Procedures	-3
	No standards describing the training for ground impact measures for remote crews	Training	+2
	No standard defining procedures for installation and maintenance	Procedures	+2
M3	Lack of standards dealing with ERP specifically developed for UAS operations (especially crew duties)	Procedures	0
	Lack of criteria to demonstrate that the number of people at risk is reduced	Procedures	-5
	Lack of standards covering training to cope with UAS emergencies	Training	-5

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Table 38 Tactical Mitigations Performance Requirements: Gap Overview

Mitigation	Gap	Classification	Score
Tactical Mitigations - VLOS	There is no existing guidance to produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic.	Procedures	-4
	There is no existing guidance to develop the procedures and protocols in support of a VLOS de-confliction scheme.	Procedures	-4
Tactical Mitigations - BVLOS	Lack of standards (i.e. MOPS) on DAA for small drones.	Technical	-11
	Lack of standards (i.e. MOPS) for small drones above VLL.	Technical	-9

Table 39 OSO: Gap Overview

Objective	Gap	Classification	Score
OSO 01	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.	Procedures	-4
OSO 02	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.	Technical	+2
OSO 03	N/A		
OSO 04	N/A		
OSO 05	N/A		
OSO 06	All identified technical standards cover Command and Control, but there is no standard to develop communication functionalities where needed/relevant.	Technical	-4
OSO 07	Absence of standards covering: Product inspection is documented and accounts for the manufacturer's recommendations if available	Procedures	10
	Absence of standards covering: A competent third party validates the training syllabus and verifies the remote crew competencies.	Procedures	-1
OSO 08, 11, 14, 21	No evidence of standards covering requirements for each element. In addition, some elements (i.e. contingency procedures or pre and post-flight inspection) may require specific standards for each type of UAS and related operation.	Procedures	-7

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	No evidence at this stage of standards covering requirements to better address the functions of crew in relation to interactions with other entities involved in UAS operations. In particular, no evidence of standard procedures with ATM or other airspace authorities (e.g. CAA, …)	Procedures	0
	No evidence of standards covering contingency or emergency procedures in detail. In particular, standards should be defined for procedures with ATM and enforcement authority units	Procedures	-5
	Absence of standards covering requirements for checklists or manuals, appropriate for staff personnel in doing standardised operational procedures (e.g. flight planning procedures, operational manual, etc.)	Procedures	-9
	No evidence of standards covering operational procedures to manage human errors, either during normal operations or emergency/contingency conditions	Procedures	-9
	Absence of standards covering any requirements to train the Remote Crew through Crew Resource Management programmes, leading them to acquire the required competence.	Training	-1
OSO 09, 15, 22	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	Training	-7
	Lack of standards covering training requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)	Training	+6
OSO 10, 12	N/A		
OSO 13	Lack of specific taxonomy (e.g. RNP 0.02 or 0.0) to define GNSS performance adequacy specifically for drone operations.	Procedures	-11
	Lack of standardised procedures for the monitoring of external services.	Procedures	+2
	Lack of testing procedures to demonstrate that GNSS performance is adequate for UAS OPS.	Procedures	-8
OSO 16	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) assignment of tasks to the crew	Procedures	-6
	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) step-by-step communications between crew members	Procedures	-6
	Absence of standards for multi crew coordination training	Training	-6

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	Absence of standards for CRM training for all persons involved in the mission	Training	-6
	Absence of standards for the devices for communication between persons involved in the mission	Technical	-7
OSO 17	Lack of criteria to address fit conditions before or during duty times	Procedures	-10
	Lack of standards to define a Fatigue Risk Management System (FRMS)	Procedures	-8
OSO 18	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS..	Technical	-2
OSO 19	Lack of specific standards for procedures able to provide at a minimum: - a clear distribution and assignment of tasks, - an internal checklist to ensure staff are adequately performing assigned tasks.	Procedures	-4
	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	Training	-5
	Lack of standards addressing systems to detect and/or recover from human errors.	Technical	-4
OSO 20	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	Technical	-4
	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission.	Procedures	-5
OSO 23	There are no standards/guidelines to define how to determine adequate environmental/ meteorological conditions for safe operations.	Procedures	-5
	Available standards for the development of procedures are quite generic and do not provide sufficient guidance.	Procedures	+2
	No current standard completely covers third-party competence for checking environmental/meteorological conditions for both syllabus and skills.	Procedures	+2
OSO 24	N/A		

Table 40 Adjacent Area/Airspace Considerations: Gap Overview

Mitigation	Gap	Classification	Score
Adjacent Area/Airspace Considerations	There is a lack of standards for SW and airborne electronic hardware (AEH) Development Assurance that are suitable for small UAS	Technical	-9

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3 Detailed Results - SORA

3.1 *M1* – Strategic Mitigations for Ground Risk

3.1.1 Requirement Description – Non-Tethered Operations

Table 41 Integrity Requirements' Description – Non-Tethered Operations

Criterion	Robustness	Description
Criterion #1 (Definition of the ground risk buffer)	Low	A ground risk buffer with at least a 1 to 1 rule or for rotary wing UA defined using a ballistic methodology approach acceptable to the competent authority.
	Medium	Ground risk buffer takes into consideration: • Improbable single malfunctions or failures (including the projection of high energy parts such as rotors and propellers) which would lead to an operation outside of the operational volume, • Meteorological conditions (e.g. wind), • UAS latencies (e.g. latencies that affect the timely manoeuvrability of the UA), • UA behaviour when activating a technical containment measure, • UA performance.
	High	Same as Medium
	Low	The applicant evaluates the area of operations by means of on-site inspections/appraisals to justify lowering the density of people at risk (e.g. residential area during daytime when some people may not be present or an industrial area at night-time for the same reason).

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Criterion #2 (Evaluation of people at risk)	Medium	Same as low, however the applicant makes use of authoritative density data (e.g. data from UTM data service provider) relevant for the proposed area and time of operation to substantiate a lower density of people at risk. AND/OR If the applicant claims a reduction, due to a sheltered operational environment, the applicant: uses a drone below 25 kg and not flying above 174 knots, demonstrates that although the operation is conducted in a populated environment, it is reasonable to consider that most of the non-active participants will be located within a building.
	High	Same as Medium.

Table 42 Assurance Requirements' Description – Non-Tethered Operations

Criterion	Robustness	Description
Criterion #1 (Definition of the ground risk buffer)	Low	The applicant declares that the required level of integrity is achieved.
	Medium	The applicant has supporting evidence to claim the required level of integrity has been achieved. This is typically done by means of testing, analysis, simulation, inspection, design review or through operational experience.
	High	The claimed level of integrity is validated by a competent third party.
Criterion #2 (Evaluation of people at risk)	Low	The applicant declares that the required level of integrity is achieved.
	Medium	The density data used for the claim of risk reduction is an average density map for the date/time of the operation from a static sourcing (e.g. census data for night time ops). In addition, for localised operations (e.g. intra-city delivery or infrastructure inspection) the applicant submits the proposed route/area of operation to the applicable authority (e.g. city police, office of civil protection, infrastructure owner etc.) to verify the claim of reduced number of people at risk.
	High	Same as medium, however the density data used for the claim of risk reduction is a near-real time density map from a dynamic sourcing (e.g. cellular user data) and applicable for the date/time of the operation.

3.1.2 Requirement Description – Tethered Operations

Table 43 Integrity Requirements' Description – Tethered Operations

Criterion	Robustness	Description

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Criterion #1 technical design	Low	Does not meet the "Medium" level criteria
	Medium	1) The length of the line is adequate to contain the UA in the operational volume and reduce the number of people at risk. 2) Strength of the line is compatible with the ultimate loads expected during the operation. 3) Strength of attachment points is compatible with the ultimate loads expected during the operation. 4) The tether cannot be cut by rotating propellers.
	High	Same as Medium
Criterion #2 procedures	Low	Does not meet the "Medium" level criteria
	Medium	The applicant has procedures to install and periodically inspect the condition of the tether.
	High	Same as Medium

Table 44 Assurance Requirements' Description – Tethered Operations

Criterion	Robustness	Description
Criterion #1 technical design	Low	Does not meet the "Medium" level criteria
	Medium	The applicant has supporting evidence (including the tether material specifications) to claim the required level of integrity is achieved. • This is typically achieved through testing or operational experience. Tests can be based on simulations, however the validity of the target environment used in the simulation needs to be justified.
	High	The claimed level of integrity is validated by EASA.
Criterion #2 procedures	Low	• Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. • The adequacy of the procedures and checklists is declared.

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	Medium	• Procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • Adequacy of the procedures is proven through: ○ Dedicated flight tests, or ○ Simulation, provided the simulation is proven valid for the intended purpose with positive results.
	High	Same as Medium. In addition: • Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. • The procedures, flight tests and simulations are validated by a competent third party.

3.1.3 Summary

Table 45 M1 - Strategic Mitigations for Ground Risk - Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness											
			Non-tethered						Tethered					
			Criterion 1			Criterion 2			Criterion 1			Criterion 2		
			L	M	H	L	M	H	L	M	H	L	M	H
Integrity														
Methodology for the UAS Operational Risk for non-geographical flight permits	ENAC	LG 2017/001-NAV	P	P	P									
General requirements for tethered unmanned aircraft system	ISO	WD 24356								(P)	(P)			
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3											F	F

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AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.	P	P	P		P							
EUROCAE Geocaging Appendix 1	EUROCAE	ED-270	P	P	P									
Unmanned Aircraft Systems — Product requirements and verification for the Open category	ASD-STAN	prEN 4709-1								P			P	P
Assurance														
AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.					P							
General requirements for tethered unmanned aircraft system	ISO	WD 24356								(P)	(P)			
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3											F	F
Unmanned Aircraft Systems — Product requirements and verification for the Open category	ASD-STAN	prEN 4709-1								P			P	

3.1.4 Integrity Coverage Detail

Table 46

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	

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Methodology for the UAS Operational Risk for non-geographical flight permits	ENAC	LG 2017/001-NAV	P	P	P											This guideline includes a method to determine the ground risk buffer in relation to the characteristics of the operational area and the system under use.

Table 47

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
General requirements for tethered unmanned aircraft system	ISO	WD 24356								(P)	(P)				The standard is only in planning phase but is expected to adequately cover the requirements for tethered operations.

Table 48

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3											F	F	The standard provides only high-level guidance. It does not provide specific guidance for procedures for on-site inspections nor for installation and monitoring of tether.

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Table 49

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.	P	P	P		P								Criterion #1 No emphasis on improbable failures required for medium robustness and above No specific guideline on demonstration Criterion#2: Partial coverage for medium robustness: definition of populated area does not answer the other items required for medium robustness No coverage for high robustness: no real time data

Table 50

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	

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EUROCAE Geocaging Appendix 1	EUROCAE	ED-270	P	P	P										No coverage without adapting appendix 1 or building new derived appendix to have a direct traceability to criterion #1 to have it agnostic of related systems If adapted high likelihood to have a full coverage

Table 51

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
Unmanned Aircraft Systems — Product requirements and verification for the Open category	ASD-STAN	prEN 4709-1								P			P	P	Standard for open category, no coverage for high robustness Criterion #2: No standards for procedures validations

3.1.1 Assurance Coverage Detail

Table 52

Standard Title	SDO	Doc. Reference	Robustness				Gaps
			Non-tethered		Tethered		
			Criterion 1	*Criterion 2*	*Criterion 1*	*Criterion 2*	

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			L	M	H	L	M	H	L	M	H	L	M	H	
AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.					P								Criterion #1 No emphasis on improbable failures required for medium robustness and above No specific guideline on demonstration Criterion#2: Partial coverage for medium robustness: definition of populated area does not answer the other items required for medium robustness No coverage for high robustness: no real time data

Table 53

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
General requirements for tethered unmanned aircraft system	ISO	WD 24356								(P)	(P)				The standard is only in planning phase but is expected to adequately cover the requirements for tethered operations.

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Table 54

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3											F	F	The standard provides only high-level guidance. It does not provide specific guidance for procedures for on-site inspections nor for installation and monitoring of tether.

Table 55

Standard Title	SDO	Doc. Reference	Robustness												Gaps
			Non-tethered						Tethered						
			Criterion 1			*Criterion 2*			*Criterion 1*			*Criterion 2*			
			L	M	H	L	M	H	L	M	H	L	M	H	
Unmanned Aircraft Systems — Product requirements and verification for the Open category	ASD-STAN	prEN 4709-1								P			P		Standard for open category, no coverage for high robustness Criterion #2: No standards for procedures validations

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3.1.2 Gaps

3.1.2.1 Summary

Table 56 Gap Summary – M1

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	No harmonised standard/guideline available for the definition of the ground risk buffer	-5	It is recommended to develop a harmonised approach at EU level for the definition of the ground risk buffer starting from the practices already available in some Member States.
2	No standard defining how to evaluate number of people at risk. More specifically absence of specific standard/guidance defining: • how to evaluate the area of operations by means of on-site inspections/appraisals to justify lowering the density of people at risk • what can be sheltered environment • what can be authoritative density data (e.g. data from UTM data service provider) relevant for the proposed area and time of operation to substantiate a lower density of people at risk. • what can be average density map for the date/time of the operation from a static sourcing (e.g. census data for night time ops). • how can be defined for localised operations (e.g. intra-city delivery or infrastructure inspection) the proposed route/area of operation to the applicable authority (e.g. city police, office of civil protection, infrastructure owner etc.) • what can be near-real time density map from a dynamic sourcing (e.g. cellular user data) and applicable for the date/time of the operation.	-6	It is recommended to develop dedicated guidance and standards, where relevant, to support operators in complying with the requirements of M1.
3	Absence of standards for the mechanical characteristics of the line	-6	ISO document "General Requirements for Tethered Unmanned Aircraft System" looks as the most promising

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			one to cover this item. It is recommended to monitor its development to ensure it can adequately cover the requirement.
4	No specific standard defining how to define installation and maintenance procedures of tether	-5	ISO document "General Requirements for Tethered Unmanned Aircraft System" looks as the most promising one to cover this item. It is recommended to monitor its development to ensure it can adequately cover the requirement.

3.1.2.2 Details

Table 57

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	No standard/guideline available for the definition of the ground risk buffer	Safety (3)	High	The absence of specific guidelines for the definition of the ground risk buffer may have negative impact on safety as adequate margins might not be retained in all operational conditions.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	The lack of standard makes more difficult and time consuming for operators to demonstrate compliance to the requirements.	-1	-2
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-5**

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Table 58

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	No standard defining how to evaluate number of people at risk	Safety (3)	High	The absence of specific requirements, concerning the issues to be assessed, may have the consequence to miss some topics that could be relevant for the safety issues. Therefore, guidelines to defining how to evaluate number of people at risk for Operators should be developed ad hoc for operational, technical and administrative topics.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	The lack of standards for the evaluation of people at risk makes more difficult and even impossible for Medium and High level of robustness to meet the requirements. At the same time, it is time consuming for oversight authorities to monitor operators.	-1	-2
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	The absence of uniformed way to assess the number of people at risk may give for social acceptance of UAS flights a negative feed-back on the competence of Operator.	-1	-1
Total Weighted Score						**-6**

Table 59

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score

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3	Absence of standard for the mechanical characteristics of the line	Safety (3)	High	The absence of specific standard for the mechanical characteristics of the line may lead to the use of inadequate equipment with a negative impact on safety.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	The lack of standards for tether makes more difficult and time consuming to evaluate its adequacy for the UAS. At the same time, it is time consuming for oversight authorities to monitor applications.	-1	-2
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	Negative	The absence of a specific standard does not allow EU companies to develop certified products.	-1	-1
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-6**

Table 60

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
4	No specific standard defining how to define installation and maintenance procedures of tether	Safety (3)	High	The absence of specific standard to address procedures for installation and maintenance of the tether may lead to incidents with a negative impact on safety.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	The lack of standards for checklists makes more difficult and time consuming for doing procedures. At the same time, it is time consuming for oversight authorities to monitor operators.	-1	-2
		Environmental Impact (1)	Neutral	-	0	0

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		Impact on EU Industry competitiveness (1)	No impact	No impact	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-5**

3.1.3 Conclusions and Recommendations

The M1 mitigation requirements are not adequately covered by existing standards.

For the non-tethered case, there is a lack of standards/guidelines to cover all the requirements. For the definition of the ground risk buffer, there exist only guidelines developed by national authorities but there is no common approach. For the evaluation of people at risk the only available standards cover, in a generic way, the procedures for on-site inspections. However, there is a complete lack of standards for the definition of a sheltered environment, what can be defined as authoritative density data, etc.

For the tethered case, there is no standard already published that can adequately cover the requirements. The ISO planned standard “General requirements for tethered unmanned aircraft system” appear to be the best candidate to fill this gap.

Table 61 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**

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Non-tethered operation - Criterion #1 (Definition of Ground Risk Buffer)	Low Medium High	Partial	ENAC-LG 2017/001-NAV - Methodology for the UAS Operational Risk for non-geographical flight permits Appendix A – "RPA casualty area determination" and Appendix B – "Probabilistic criteria for the buffer determination	Some items as latencies not taken into account Lack of sample to adequately meet the requirements for applicants	5	No harmonized standard/guideline available for the definition of the ground risk buffer
		Partial	DGAC AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4 - §18.3.- « Protection des tiers au sol » (« uninvolved people on ground protection »)	No emphasis on improbable failures required for Med robustness and above No specific guideline on demonstration	5	
		Partial	EUROCAE ED-270 Geocaging Appendix 1	No full coverage without adapting appendix 1 or building new derived appendix to have a direct traceability to criterion #1 to have it agnostic of related systems	4	
Non-tethered operation - Criterion #2 (Evaluation of people at risk)	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Partial	DGAC AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4 - §18.3.- « Protection des tiers au sol » (« uninvolved people on ground protection »)	definition of populated area is some kind of "authorized data" but does not answer the other items required for M/H robustness.	1	No standard/guidance defining how to evaluate number of people at risk.
	High	N.A.	NO STANDARD AVAILABLE		N/A	
	Low	N.A.	NO STANDARD REQUIRED	N/A		

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Tethered operation - Criterion #1 technical design	Medium	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Still in planning phase, draft needs to be checked but it is expected to provide generic guidance	N.A.	Lack of technical standard applicable to all classes of drones.
		Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	
	High	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Still in planning phase, draft needs to be checked	N.A.	
Tethered operation - Criterion #2 procedures	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium High	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	No specific standard defining how to define installation and maintenance procedures of tether
		Full	ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	Not specific for installation and maintenance of a tether	10	

Table 62 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Non-tethered operation - Criterion #1 (Definition of the ground risk buffer)	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	N.A.	NO STANDARD REQUIRED	N/A		
Non-tethered operation - Criterion #2 (Evaluation of people at risk)	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	Partial	DGAC - AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	definition of populated area is some kind of "authorized data" but does not answer the other items required for Med robustness	1	No standard/guidance defining how to evaluate number of people at risk. For High robustness no guidance on the definition of real time data.
	High	N.A.	NO STANDARD AVAILABLE		N/A	
Tethered operation - Criterion #1 technical design	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	
	Medium High	(Partial)	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Still in planning phase, draft needs to be checked	N.A.	
	Low	N.A.	NO STANDARD REQUIRED	N/A		

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Tethered operation - Criterion #2 procedures	Medium	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	
	Medium High	Full	ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	Not specific for installation and maintenance of a tether. This standard could provide full assurance if operators use detailed standards for the development of the procedures	10	

3.2 *M2* – Effects of UA impact dynamics are reduced

3.2.1 Requirement Description

Table 63 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	Does not meet the "Medium" level criterion

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(Technical Design)	Medium	Ground risk buffer takes into consideration: • Effects of impact dynamics and post impact hazards are significantly reduced although it can be assumed that a fatality may still occur. • When applicable, in case of malfunctions, failures or any combinations thereof that may lead to a crash, the UAS contains all elements required for the activation of the mitigation. • When applicable, any failure or malfunction of the proposed mitigation itself (e.g. inadvertent activation) does not adversely affect the safety of the operation.
	High	Same as medium. In addition: • When applicable, the activation of the mitigation, is automated. • The effects of impact dynamics and post impact hazards are reduced to a level where it can be reasonably assumed that a fatality will not occur.
Criterion #2 (Procedures, if applicable)	Low	Any equipment used to reduce the effect of the UA impact dynamics are installed and maintained in accordance with manufacturer instructions.
	Medium	
	High	
Criterion #3 (Training, if applicable)	Low	Personnel responsible for the installation and maintenance of the measures proposed to reduce the effect of the UA impact dynamics are identified and trained by the applicant.
	Medium	
	High	

Table 64 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Technical Design)	Low	The applicant declares that the required level of integrity has been achieved.
	Medium	The applicant has supporting evidence to claim the required level of integrity is achieved. This is typically done by means of testing, analysis, simulation, inspection, design review or through operational experience.
	High	The claimed level of integrity is validated by EASA against a standard considered adequate by EASA and/or in accordance with means of compliance acceptable to EASA (when applicable).

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Criterion #2 (Procedures, if applicable)	Low	• Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. • The adequacy of the procedures and checklists is declared

	Medium	• Procedures are validated against standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority.
		• The adequacy of the procedures is proved through:
		  ○ Dedicated flight tests, or
		  ○ Simulation, provided that the representativeness of the simulation means is proven for the intended purpose with positive results.

	High	Same as Medium. In addition: • Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. • The procedures, flight tests and simulations are validated by a competent third party.
Criterion #3 (Training, if applicable)	Low	Training is self-declared (with evidence available).
	Medium	• Training syllabus is available. • The operator provides competency-based, theoretical and practical training.
	High	• Training syllabus is validated by a competent third party. • Remote crew competencies are verified by a competent third party

3.2.2 Summary

Table 65 M2 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*		
			L	M	H	L	M	H	L	M	H
Integrity											
Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	ASTM	F3322-18		P	P						
Assurance											

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Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	ASTM	F3322-18		P	P						

3.2.3 Integrity Coverage Detail

Table 66

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	ASTM	F3322-18		P	P							-Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. The Civil Aviation Authority (CAA) will likely define the safe energy levels or accept proposed levels by the applicant based on the operation. -A competent third party for validation efforts is not provided. The CAA will have to define competent third parties.

Notes:

F3322-18 is a specification that defines design, manufacturing, and test requirements for the parachute system. It does not provide minimum requirements related to the ground impact effects as this will likely be dependent on the governing CAA. Requirements are included for the type of procedures which are necessary but not on the development or format. No requirements are presented related to training.

3.2.1 Assurance Coverage Detail

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Table 67

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	ASTM	F3322-18		P	P							-Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. The Civil Aviation Authority (CAA) will likely define the safe energy levels or accept proposed levels by the applicant based on the operation. -A competent third party for validation efforts is not provided. The CAA will have to define competent third parties.

Notes:

F3322-18 is a specification that defines design, manufacturing, and test requirements for the parachute system. It does not provide minimum requirements related to the ground impact effects as this will likely be dependent on the governing CAA. Requirements are included for the type of procedures which are necessary but not on the development or format. No requirements are presented related to training.

3.2.2 Gaps

3.2.2.1 Summary

Table 68 Gap Summary – M2

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required.	-6	Uniform techniques for the analysis of reduction of the effects of impact dynamics and post impact hazards should be developed.

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2	No standards for contingency or emergency procedures containing means of reduction of ground impact	-3	Guidance for the definition of contingency or emergency procedures containing means of reduction of ground impact could help operators in assessing all the relevant aspects.
3	No standards describing the training for ground impact measures for remote crews	+2	It is of aid to have standards that address the training for ground impact measures.
4	No standard defining procedures for installation and maintenance	+2	It is assumed that standards covering the development of systems to reduce the effects of ground impact will also include instructions for maintenance and installation.

3.2.2.2 Details

Table 69

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required.	Safety (3)	High	Implementation standards for automated activation of recovery systems need to be developed if this technique is used to assure the integrity of the recovery system. Declaration of the effects of impact dynamics and post impact hazards have to be standardised.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	Costs are to be expected to realize system for automated activation of recovery system. Techniques for reasonable reduction of the effects of impact dynamics and post impact hazards might also lead to increasing development cost.	-1	-2
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Negative	Due to increasing development cost EU industry competitiveness could be affected negatively.	-1	-1

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		Social Acceptance (1)	Neutral	No impact	0	0
Total Weighted Score						**-6**

Table 70

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	No standards for contingency or emergency procedures containing means of reduction of ground impact	Safety (3)	High	Contingency and emergency conditions need to be standardised in order to apply the "best" way to handle technical issues. Contingency/emergency procedures will support UAV pilots to manage the non-nominal situation.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	Costs are to be expected to realise the procedures and to train the personnel to apply.	0	0
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Neutral	No impact	0	0
		Social Acceptance (1)	Neutral	No impact	0	0
Total Weighted Score						**-3**

Table 71

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3		Safety (3)	Medium	Ground impact measures are mostly quite intuitive, usually no training is required. However, systems that	0	0

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	No standards describing the training for ground impact measures for remote crews			require training should have a standard describing the content of this training.		
		Cost of compliance to the requirement with a lack standard (2)	Low	No more than a training course or short introduction to such systems is required.	+1	+2
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Neutral	No impact	0	0
		Social Acceptance (1)	Neutral	No impact	0	0
Total Weighted Score						**+2**

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
4	No standard defining procedures for installation and maintenance	Safety (3)	Medium	Procedures for installation and maintenance are likely to be provided by the manufacturer also in absence of a dedicated standard.	0	0
		Cost of compliance to the requirement with a lack standard (2)	Low	Procedures for installation and maintenance are likely to be provided by the manufacturer also in absence of a dedicated standard.	+1	+2
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Neutral	No impact	0	0
		Social Acceptance (1)	Neutral	No impact	0	0
Total Weighted Score						**+2**

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3.2.3 Conclusions and Recommendations

Criterion #1 of M2 seems to be adequately covered by standards that are either published or under development. However, no standard covers the definition of criteria to assess the ground impact effects versus the likelihood of a fatality. The competent authority will likely need to define the safe energy levels or accept the levels proposed by the applicant based on the operation. A harmonization of these thresholds at European level would be desirable. Similar for Criterion #3, no standard has been identified to fully cover the training requirements to reduce dynamics impact. ASMT WK60659 will outline qualification and training required for UAS maintenance technicians with broad understanding of supporting the continued airworthiness of UAS platforms and their subsystems, including systems that will improve control over effects of impact dynamics. However, at the time of writing this document, the standard is not available.

The gap for installation and maintenance personnel is expected to be covered by current ASTM developments (ASTM WK60659). If a draft is available this will be included in the next iteration of this document.

The most critical gaps are related to the absence of standards covering the definition of contingency or emergency procedures containing means of reduction of ground impact. These gaps should be addressed by either developing dedicated standards or covering these topics in existing ones. For example, procedures for contingency and emergency could be covered in general standards such as ISO 21384-3:2019 Unmanned aircraft systems — Part 3: Operational procedures.

EUROCAE proposes to develop a new standard based on ETSO-C23d (personnel parachutes assemblies) and ETSO-C23f (personnel parachutes assemblies and components) to cover part of the existing gaps. We concur that this could be a good solution, provided that there is an interest from the industry.

For further use it may be helpful to explicitly divide between component and integration level for emergency systems. In this way it may be possible to include ETSOs to increase economic feasibility. However, this is not necessarily needed to comply with the requirements from M2.

Table 72 Recommended Standards - Integrity

Integrtity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps

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Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	F3322-18: Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	F3322-18 is a specification that defines design, manufacturing, and test requirements for the parachute system. It does not provide minimum requirements related to the ground impact effects as this will likely be dependent on the governing CAA. Requirements are included for the type of procedures which are necessary but not on the development or format. Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. The Civil Aviation Authority (CAA) will likely define the safe energy levels or accept proposed levels by the applicant based on the operation.	4	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required. No standards for contingency or emergency procedures containing means of reduction of ground impact.
	High	Partial				
Criterion #2 (Procedures, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standard defining procedures for installation and maintenance
Criterion #3 (Training, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standards describing the training for ground impact measures

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Table 73 Recommended Standards - Assurance

Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	F3322-18: Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	F3322-18 is a specification that defines design, manufacturing, and test requirements for the parachute system. It does not provide minimum requirements related to the ground impact effects as this will likely be dependent on the governing CAA. Requirements are included for the type of procedures which are necessary but not on the development or format. Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. The Civil Aviation Authority (CAA) will likely define the safe energy levels or accept proposed levels by the applicant based on the operation.	4	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required. No standards for contingency or emergency procedures containing means of reduction of ground impact.
	High	Partial				
Criterion #2 (Procedures, if applicable)	Low	N/A	NO STANDARD REQUIRED			
	Medium	N/A	NO STANDARDS AVAILABLE		N/A	No standard defining procedures for installation and maintenance
	High					
Criterion #3	Low	N/A	NO STANDARD REQUIRED			

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(Training, if applicable)	Medium	N/A	NO STANDARDS AVAILABLE		N/A	No standards describing the training for ground impact measures
	High					

3.3 *M3* – An Emergency Response Plan is in place, operator validated and effective

3.3.1 Requirement Description

Table 74 Integrity Requirements' Description

Criterion	Robustness	Description
Integrity Criteria	Low	No ERP is available, or the ERP does not cover the elements identified to meet a "Medium" or "High" level of integrity.
	Medium	The ERP: • is suitable for the situation; • limits the escalating effects; • defines criteria to identify an emergency situation; • is practical to use; • clearly delineates Remote Crew member(s) duties
	High	Same as Medium. In addition, in case of loss of control of the operation, the ERP is shown to significantly reduce the number of people at risk although it can be assumed that a fatality may still occur.

Table 75 Assurance Requirements' Description

Criterion	Robustness	Description

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Assurance Criterion #1 (Procedures)	Low	Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. The adequacy of the procedures and checklists is declared.
	Medium	The ERP is developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority. The ERP is validated through a representative tabletop exercise consistent with the ERP training syllabus.
	High	Same as Medium. In addition: • The ERP and the effectiveness of the plan with respect to limiting the number of people at risk are validated by a competent third party. • The applicant has coordinated and agreed the ERP with all third parties identified in the plan. • The representativeness of the tabletop exercise is validated by a competent third party.
Assurance Criterion #2 (Training)	Low	Does not meet the "Medium" level criterion
	Medium	• An ERP training syllabus is available. • A record of the ERP training completed by the relevant staff is established and kept up to date.
	High	Same as Medium. In addition, competencies of the relevant staff are verified by a competent third party.

3.3.2 Summary

The following requirements are disregarded in this section as they are not supposed to be mapped with any specific standard:

- Integrity (Low)
- Assurance Criterion #1 (Low)
- Assurance Criterion #2 (Low)

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Table 76 M3 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Integrity Robustness *Criterion*			Assurance Robustness *Criterion 1 (procedures)*			Assurance Robustness *Criterion 2 (training)*		
			L	M	H	L	M	H	L	M	H
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P		P	P			
Unmanned aircraft systems -Training for personnel involved in UAS operations	ISO	23665		P	P		P	P		P	P
Emergency Response Plan	IATA	N/A		P	P		P	P			

3.3.3 Coverage Detail

Table 77

Standard Title	SDO	Doc. Reference	Integrity Robustness *Criterion*			Assurance Robustness *Criterion 1 (procedures)*			Assurance Robustness *Criterion 2 (training)*			Gaps
			L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P		P	P				Medium: - Criteria to define emergency situations; - Template practical to use High: - Does not clearly delineate remote crew duties

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Notes:
The standard does not provide a template or specific guidance on how to prepare an ERP. However, the document contains high-level guidance on basic operational procedures in case of emergency, including communication with relevant entities and predisposition of emergency equipment.

Table 78

Standard Title	SDO	Doc. Reference	Integrity Robustness *Criterion*			Assurance Robustness *Criterion 1* *(procedures)*			Assurance Robustness *Criterion 2* *(training)*			Gaps
			L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -Training for personnel involved in UAS operations	ISO	23665		P	P					P		Medium: Template impractical to use High: - Criteria to demonstrate that the number of people at risk is reduced

Notes:
The standard is not focused on the ERP for UAS OPS as it is mostly dedicated to personnel training. However, it provides a good guidance on the ERP content, including classification of emergency actions (although not exhaustive), procedures in case of loss of control of the operation and training activities.
In conclusion, in absence of standards completely dedicated to the ERP for UAS operations, this document could be considered a good starting point.

Table 79

Standard Title	SDO	Doc. Reference	Integrity Robustness *Criterion*	Assurance Robustness *Criterion 1* *(procedures)*	Assurance Robustness *Criterion 2* *(training)*	Gaps

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			L	M	H	L	M	H	L	M	H	
Emergency Response Plan	IATA			P	P		P	P				Medium: - Duties not tailored for UAS remote crew - Criteria to define emergency situations High: - Criteria to demonstrate that the number of people at risk is reduced

Notes:

The document provides a practical template for air carriers to handle emergency situations. The document includes roles and responsibilities for the ERT (Emergency Response Team). Although this ERP is not tailored for UAS operations, some actions, checklists, ect. could be adapted. However, the document does not provide criteria to establish the adequacy of the ERP for a certain situation as well as criteria to demonstrate that the number of people at risk is reduced. These issues are very specific for UAS operations.

3.3.4 Gaps

3.3.4.1 Summary

Table 80 Gap Summary – M3

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of standards dealing with ERP specifically developed for UAS operations (especially crew duties)	0	The urgency to develop a standard for the ERP depends on the type of operation (e.g. SAIL). The ERP is not mandatory in SORA but it is desirable since its absence determines a one point increase in the GRC. Therefore, it is recommended to develop standard for ERP to support complex operations dealing with potentially high SAILs and including the assignment of duties to crew.

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2	Lack of criteria to demonstrate that the number of people at risk is reduced	-5	It is recommended to develop such criteria as a function of the type of operation. The lack of such criteria would make more difficult to judge the effectiveness of the ERP.
3	Lack of standards covering training to cope with UAS emergencies	-5	Several good standards dedicated to remote crew training are already being developed. Therefore, it is recommended not to develop a new standard but to amend the ones under development (e.g. ISO 23665) to include also a training syllabus dedicated to the ERP.

3.3.4.2 Details

Table 81

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of standards dealing with ERP specifically developed for UAS operations (especially crew duties)	Safety (3)	Medium	Most UAS operators do not have specific emergency procedures in their operations manual and tend to confuse contingency and emergency procedures. A standard would be required to define harmonised procedures. However, the ERP is not a mandatory mitigation required by SORA. In general, the impact on safety depends on the complexity of the operation and the type of UAS. For operations in sparsely populated environment the need for an ERP is not so evident as most of abnormal situations are likely to be handled by automatic recovery procedures. For very complex operations (e.g. OPS in controlled airspace in airport environment) the impact would be higher since it is required to interact with ATC in case of emergency. Hence it is assumed that the impact on safety in average is medium.	0	0

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		Cost of compliance to the requirement with a lack standard (2)	Medium	For operators, the lack of a standard means that they have to build their own ERP without specific best practices, but the cost is not expected to be high as this is what occurs for most operators today. The cost of compliance is higher for authorities when verifying the effectiveness of the ERP on a case-by-case basis.	0	0
		Environmental Impact (1)	Neutral		0	0
		Impact on EU Industry competitiveness (1)	Positive	The lack of ERP standards would increase the business of UAS consultancy companies with expertise in risk management.	1	1
		Social Acceptance (1)	Negative	In case of incident/accident (resulting in fatalities, damages etc), the lack of recognised procedures to handle emergency situations could be seen negatively from a social perspective.	-1	-1
Total Weighted Score						**0**

Table 82

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of criteria to demonstrate that the number of people at risk is reduced	Safety (3)	High	The lack of recognised criteria to evaluate that the number of people at risk is reduced leads to the difficulty to assess the effectiveness of an ERP. This is more relevant for operators with poor aeronautical culture who may not be able to develop an ERP suitable for the intended operation.	-1	-3

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		Cost of compliance to the requirement with a lack standard (2)	High	For operators, the lack of these criteria means that they have to build a safety case on their own. Usually operators are not familiar with risk management techniques and will be probably obliged to ask for consultancy services. The cost of compliance is high for authorities as they have to verify the effectiveness of the ERP on a case-by-case basis.	-1	-2
		Environmental Impact (1)	No impact		0	0
		Impact on EU Industry competitiveness (1)	Positive	The lack of ERP standards would increase the business of UAS consultancy companies with expertise in risk management.	1	1
		Social Acceptance (1)	Negative	In case of incident/accident (resulting in fatalities, damages etc), the lack of recognised procedures to handle emergency situations could be seen negatively from a social perspective.	-1	-1
Total Weighted Score						-5

Table 83

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	Lack of standards covering training to cope with UAS emergencies	Safety (3)	High	Personnel should be always adequately trained to cope with emergency situations. Experience and skills are needed to handle such situations safely and a dedicated training programme should be developed.	-1	-3

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3		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standards does not help authorities to verify remote crew skills.	0	0
		Environmental Impact (1)	No impact		0	0
		Impact on EU Industry competitiveness (1)	Negative	The lack of standards does not support flight schools in developing training programmes.	-1	-1
		Social Acceptance (1)	Negative	In case of incident/accident (resulting in fatalities, damages etc), the lack of recognised training requirements to handle emergency situations could be seen negatively from a social perspective.	-1	-1
Total Weighted Score						**-5**

3.3.5 Conclusions and Recommendations

Currently, requirement M3 is not covered by any existing standard/guidance material/best practice.

The ERP represents one of the three mitigations for Ground Risk in SORA. However, since in SORA the ERP is an optional mitigation, the priority of this standardisation is not high and mainly depends on the type of operation. Therefore, it is recommended to develop ERP strategies to handle emergency situations for critical operations (e.g. OPS in airport environment). In addition, there is no need to develop a specific standard for ERP training, but it will be enough to amend standards under development (e.g. ISO 23665) to include ERP related training activities.

Additional notes:

- Although the ERP in SORA is an optional mitigation, EASA has already included the need to have an ERP in the draft STS (ref. Opinion 05/2019) and in the first set of AMC for Pre-Defined Risk Assessment (PDRA).

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- EASA is developing guidance material specifically tailored for the SORA methodology, aimed at covering the requirements set by M3.

Table 84 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Integrity Criteria	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3: Operational Procedures	Standard provides only high-level guidance	2	Absence of criteria to demonstrate that the number of people at risk is reduced Lack of standards dealing with ERP specifically developed for UAS operations (especially crew duties)
	High	Partial	ISO 21384-3: Operational Procedures	Standard provides only high-level guidance	4	
			IATA Emergency Response Plan	The document contains a sample template for an ERP applicable to large scale public health emergencies, and hence its application is not deemed proportional to small UAS operations.	2	

Table 85 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
	Low	N/A	NO STANDARD REQUIRED			

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Assurance Criterion #1 (Procedures)	Medium	Partial	ISO 21384-3: Operational Procedures	Standard provides only high-level guidance	2	
	High	Partial	ISO 21384-3: Operational Procedures	Standard provides only high-level guidance	4	
Assurance Criterion #2 (Training)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	ISO 23665 Unmanned aircraft systems - Training for personnel involved in UAS operations	Not yet published: FDIS stage	2	Lack of standards covering training related to UAS emergencies
	High	Partial				

The following matrix further highlights the applicability of each assessed standard to the criteria set by the requirement.

Table 86 Standards' Applicability

Int/Ass	Requirement	ISO 21384-3	ISO 23665	IATA ERP
Integrity	ERP Suitable for the situation (UAS OPS)	✔	✔	X
	ERP Practical to use	X	X	✔
	Criterion to define emergency situations	X	✔	✔
	Remote Crew duties	X	X	X
	Criterion for reduction of people at risk	X	X	X
Assurance	Procedures	✔	X	X
	Training syllabus (covered in Session 5)	X	✔	X

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3.4 Tactical Mitigations Performance Requirements - VLOS

3.4.1 Requirement Description

Table 87 Requirements' Description

Criterion	Description
Criterion #1 (De-confliction scheme)	The operator should produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic.
Criterion #2 (Phraseology, procedures and protocols)	If the remote pilot relies on detection by observers, the use of communication phraseology, procedures, and protocols should be described. Since the VLOS operation may be sufficiently complex a requirement to document and approve the VLOS strategy is necessary before authorization and approval by the competent authority and/or ANSP.

3.4.2 Summary

Table 88 Tactical Mitigations - VLOS Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	*Criterion 1*	*Criterion 2*
Standard Practice for Communications Procedures—Phonetics	ASTM	F1583-95(2019)		P

3.4.3 Coverage Detail

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Table 89

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*	Robustness *Criterion 2*	Gaps
Standard Practice for Communications Procedures—Phonetics	ASTM	F1583-95(2019)		P	There is no existing guidance to produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic. There is no existing guidance to develop the procedures and protocols in support of a VLOS de-confliction scheme.
Notes: The requirement is not fully covered by any standard. A gap can be therefore identified possibly suggesting the development of a specific standard for the definition of de-confliction schemes for VLOS operations and related procedures, phraseology and protocols.					

3.4.4 Gaps

3.4.4.1 Summary

Table 90 Gap Summary – Tactical Mitigations - VLOS

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	There is no existing guidance to produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic.	-4	The gap is not particularly critical. However the development of specific guidance material for the development of VLOS de-confliction schemes would be beneficial for uniform safety and EU industry perspectives.

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2	There is no existing guidance to develop the procedures and protocols in support of a VLOS de-confliction scheme.	-4	The gap is not particularly critical. However the development of specific guidance for the development of procedures and protocols for VLOS de-confliction schemes would be beneficial for uniform safety in EU.

3.4.4.2 Details

Table 91

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	There is no existing guidance to produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic.	Safety (3)	High	The lack of a standardized way to develop a VLOS de-confliction scheme (e.g. VLL priority rules, procedures for remaining well clear in drone-to-drone) might compromise uniform safety.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The cost of developing a VLOS de-confliction scheme in absence of a reference standard is medium on average since the UAS operator could easily develop its own, especially if he has significant experience. On the other side, the evaluation of the effectiveness of the proposed de-confliction scheme by the authority can be more difficult as each proposed scheme will need to be separately evaluated without a common reference.	0	0
		Environmental Impact (1)	Neutral	No significant environmental impact is foreseen	0	0
		Impact on EU Industry competitiveness (1)	Negative	VLOS Operations in specific areas can be limited in absence of a reliable VLOS de-confliction scheme. According to the SESAR Drone Outlook study, VLOS operations in the EU will reach 100k/year in the Specific category leading to an overall negative impact on EU industry	-1	-1

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		Social Acceptance (1)	No impact	No impact is foreseen on social acceptance	0	0
Total Weighted Score						**-4**

Table 92

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	There is no existing guidance to develop the procedures and protocols in support of a VLOS/E-VLOS de-confliction scheme.	Safety (3)	High	The lack of a standardized way to develop an E-VLOS de-confliction scheme might compromise uniform safety across all UAS operations.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The cost of developing procedures and protocols VLOS de-confliction scheme in absence of a reference standard is medium on average since the UAS operator could easily develop its own, especially if he has significant experience. On the other side, the evaluation of the effectiveness of the proposed de-confliction scheme by the authority can be more difficult as each proposed procedures will need to be separately evaluated without a common reference.	0	0
		Environmental Impact (1)	Neutral	No significant environmental impact is foreseen	0	0
		Impact on EU Industry competitiveness (1)	Negative	VLOS Operations in specific areas can be limited in absence of a reliable VLOS procedures and protocols. According to the SESAR Drone Outlook study, VLOS operations in the EU will reach 100k/year in the Specific category leading to an overall negative impact on EU industry	-1	-1
		Social Acceptance (1)	No impact	No impact is foreseen on social acceptance	0	0

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Total Weighted Score	-4

3.4.5 Conclusions and Recommendations

The main gap to be addressed in relation to VLOS Tactical mitigation is the absence of guidance to develop de-confliction schemes that are suitable for the operations. It is therefore recommended to develop dedicated guidance material to help operators produce a VLOS de-confliction scheme, where the methods that will be applied for detection and the criteria used to avoid incoming traffic are explained, along with the procedures that are in place to support such scheme.

Additional notes:

- It is noted that de-confliction between drones is currently out of SORA scope. It is therefore recommended to develop dedicated guidance material to help operators produce a VLOS/E-VLOS de-confliction scheme, where the methods that will be applied for detection and the criteria used to avoid incoming traffic are explained, along with the procedures that are in place to support such scheme.

Table 93 Recommended Standards

Criterion	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1 (De-confliction scheme)	N/A	NO STANDARD AVAILABLE		N.A.	There is no existing guidance to produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic. There is no existing guidance to develop the procedures and protocols in support of a VLOS de-confliction scheme.

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Criterion #2 (Phraseology, procedures and protocols)	Partial	ASTM F1583-95 (2919): Standard practice for communications procedures - phonetics	Potentially covers the definition of appropriate phraseology in support of VLOS de-confliction procedures	6	Not specific for UAS operations

3.5 Tactical Mitigations Performance Requirements - BVLOS

3.5.1 Requirement Description

Table 94 Requirements' Description

Function	Arc	Requirement Description
Detect	Arc-a	No requirement
	Arc-b	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50% of all aircraft in the detection volume. This is the performance requirement in absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM/Pilot Aware aircraft trackers • Use of UTM Dynamic Geofencing • Monitoring aeronautical radio communication (i.e. use of a scanner)
	Arc-c	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90% of all aircraft in the detection volume.

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		To accomplish this, the applicant will have to rely on one or a combination of the following systems or services: • Ground based DAA /RADAR • FLARM • Pilot Aware • ADS-B In/ UAT In Receiver • ATC Separation Services • UTM Surveillance Service • UTM Early Conflict Detection and Resolution Service • Active communication with ATC and other airspace users The operator provides an assessment of the effectiveness of the detection tools/methods chosen.
	Arc-d	A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.
Decide	Arc-a	No requirement.
	Arc-b	The operator must have a documented deconfliction scheme, in which the operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing an alert boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'DESCEND!, DESCEND!, DESCEND!'.
	Arc-c	All requirements of ARC 2 and in addition: 1. The operator provides an assessment of the human/machine interface factors that may affect the remote pilot's ability to make a timely and appropriate decision.

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		2. The operator provides an assessment of the effectiveness of the tools and methods utilized for the timely detection and avoidance of traffic. In this context timely is defined as enabling the remote pilot to decide within 5 seconds after the indication of incoming traffic is provided. The operator provides an assessment of the failure rate or availability of any tool or service the operator intends to use.
	Arc-d	A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.
Command	Arc-a	No requirement.
	Arc-b	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command must not exceed 5 seconds.
	Arc-c	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command must not exceed 3 seconds.
	Arc-d	A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.
Execute	Arc-a	No requirement.
	Arc-b	UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute.
	Arc-c	Avoidance may rely on vertical and horizontal avoidance manoeuvring and is defined in standard procedures. Where horizontal manoeuvring is applied, the aircraft shall be demonstrated to have adequate performance, such as airspeed, acceleration rates, climb/descend rates and turn rates. The following are suggested minimum performance criteria: • Airspeed: ≥ 50 knots • Rate of climb/descend: ≥ 500 ft/min • Turn rate: ≥ 3 degrees per second

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	Arc-d	A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.
Feedback Loop	Arc-a	No requirement.
	Arc-b	Where electronic means assist the remote pilot in detecting traffic, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate.
	Arc-c	The information is provided to the remote pilot with a latency and update rate that support the decision criteria. The applicant provides an assessment of the aggravated closure rates considering traffic that could reasonably be expected to operate in the area, traffic information update rate and latency, C2 Link latency, aircraft manoeuvrability and performance and sets the detection thresholds accordingly. The following are suggested minimum criteria: • Intruder and ownship vector data update rates: ≤ 3 seconds.
	Arc-d	A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

Table 95 Air Risk Class Tactical Mitigation Requirements

	Arc-a	Arc-b	Arc-c	Arc-d
Tactical Mitigation Integrity	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH). The requirement is considered to be met by	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH). The requirement is considered to be met by commercially available products.	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 1,000 Flight Hours (1E-3 Loss/FH). This rate is commensurate with a probable failure condition.	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100,000 Flight Hours (1E-5 Loss/FH). A quantitative analysis is required.

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	commercially available products. No quantitative analysis is required.	No quantitative analysis is required.		
Tactical Mitigation Assurance	No Assurance Required.	The operator is declaring that the Tactical Mitigation System and procedures will mitigate the risk of collisions with manned aircraft to an acceptable level.	The operator provides evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level.	The evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level is verified by a competent third party.

3.5.2 Summary

Table 96 Tactical Mitigations - BVLOS Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)
RTCA DO-365: Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems-Phase 1	All	d	P
RTCA DO-365A: Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems-Phase 2	Detect Decide	d	P
RTCA DO-366: Minimum Operational Performance Standards for Air To Air Radar for Detect And Avoid Systems	Detect	d	P
	F. Loop	d	P
	Integrity	d	P
RTCA DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	Detect	d	P
	Decide	d	P
	F. Loop	d	P

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	Integrity	d	F
RTCA DO-376: Minimum Operational Performance Standards for Airborne Collision Avoidance System Xu (ACAS Xu)	All	d	P
EUROCAE ED-271: Minimum Aviation System Performance Standard (End-to-end Requirements at system level) for DAA of IFR Flights in class A-C airspace	All	d	P
EUROCAE ED 258: Operational services and environment description (OSED) for detect and avoid in class D-G airspaces under VFR/IFR	Detect	b c d	P
	Decide	d	P
EUROCAE ED-267: Operational Services and Environmental Description for DAA in Very Low-Level Operations	Detect	d	P
	Decide	d	P
	Command	d	P
EUROCAE ED-265: Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)	Command	d	P
	Feedback Loop	d	P
ASTM F3442 - Detect and Avoid performance Requirements	All	-	(P)
ASTM WK62669 - Detect and Avoid Testing Requirements	-	-	(P)
ASTM WK69690 - Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	-	-	(P)

3.5.3 Coverage Detail

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Table 97

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
ASTM F3442 - Detect and Avoid performance Requirements	-	-	(P)	Document unavailable
This document defines minimum performance standards for DAA systems applicable to smaller UAS BLVOS operations for the protection of manned aircraft in lower altitude airspace, defining specific safety performance thresholds for a DAA system to meet to ensure safe operation. It applies to UA with a maximum dimension ≤25 ft, operating at airspeeds below 100 kts, and of any configuration or category. It is meant to be applied in a “lower risk” (low- and medium-risk airspace as described by JARUS) airspace environment with assumed infrequent encounters with manned aircraft. The full document was not available to the consortium, and hence a complete assessment could not be conducted.				

Table 98

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
ASTM WK62669 - Detect and Avoid Testing Requirements	-	-	(P)	Document unavailable Document on-going
This document defines test methods for DAA systems and sensors applicable to smaller UAS BLVOS operations for the protection of manned aircraft in lower altitude airspace. The full document was not available to the consortium, and hence a complete assessment could not be conducted.				

Table 99

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)

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ASTM WK69690 - Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	-	-	(P)	Document unavailable Document on-going
This standard defines minimum performance standards for Surveillance Supplemental Data Service Providers (SDSP) equipment and services to UAS Service Suppliers/Providers (USS/USP) in a UAS Traffic Management (UTM) ecosystem. These surveillance services will provide aircraft track information to Detect and Avoid (DAA) systems to enable BLVOS UAS operations. This document is potentially aimed at UAS service providers. The full document was not available to the consortium, and hence a complete assessment could not be conducted.				

Table 100

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
RTCA DO-365: Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems-Phase 1	All	d	P	Gaps have been identified in terms of minimum drone size and airspace applicability. The MOPS assume that all equipment that supports or sends data to the DAA system is at a design assurance level appropriate for the intended function. Other standards (e.g. RTCA DO 178C for software) can be used to ensure that the system meets such requirement.
Notes: ***General and applicability:*** The document provides a standard for DAA for UAS operating within the American National Airspace System (NAS). The MOPS contain architectural requirements for different components constituting the DAA concept, in particular the UA segment, the Ground Control Station. The MOPS apply to UAS (any configuration) with a MTOM greater than 55 lbs (i.e. 25 kg) and do not address the following conditions: • Any visual separation clearance or flight under Visual Flight Rules (VFR); • Operations in the VFR traffic pattern of an airport; • Ground taxi operations;				

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- Flights operating in Class A, B, or C airspace;
- Detection of terrain, obstacles, adverse weather (out of scope of SORA TMPR)
- Bird encounters (out of scope of SORA TMPR)
- All types of UAS (out of scope of SORA TMPR)

The DAA system will allow a UAS pilot to conduct IFR flight operations between an airport or launch/recovery zone, where another means of traffic separation is provided.

Detect function:

Three types of detection sensors are considered including active airborne surveillance, ADS-B In and airborne radar. These sensors allow to detect most of the traffic (also non-cooperative aircraft).

MOPS for specific radar requirement are contained in DO-366. However, radar operational performance requirements at the aircraft level and associated recommendations are derived from the UAS DAA MOPS DO-365.

Decide Function:

The standard provides the conditions in which an alert must be provided to the remote pilot (i.e. when the intruder is inside the so called "hazard zone"). Specification on display of traffic information are provided.

Different alert levels are available and guidance on avoidance manoeuvres and remote pilot actions are provided as well for different conditions.

Command function:

Minimum performance requirements in terms of (terrestrial) datalink communication are provided in terms of availability,latency,etc in a dedicated appendix that reprises DO-362 (MOPS for Terrestrial C2 Link).

Satellite datalink is addressed in the phase 2 MOPS.

Execute function:

Flight dynamics performance specifications are provided in terms of turn rate and vertical manoeuvres.

Feedback loop:

Requirements on minimum data rate for intruder data are provider for different conditions and sensors.

In conclusion these MOPS are fully compliance with the most demanding SORA TMPR requirements (i.e. ARC-d requirements). As a consequence, the MOPS fulfil also requirements associated to lower Air Risk Classes. Consequently, also with lower Air Risk Classes.

Anyway the requirements are too demanding (and hardly applicable) for small drones operating in the Specific Category. In addition, the MOPS require equipment certification according to recognised FAA TSO (this is reasonable at maximum for Arc-d where safety requirements are expected to be comparable to the Certified Category).

Future revisions of this document are expected to address other operational scenarios and sensors better suited to smaller UAS needs, as well as other DAA architectures, including ground-based sensors.

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Table 101

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
RTCA DO-365A: Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems-Phase 2	Detect	d	P	The document does not contain MOPS and there are limitations in terms of drone size and airspace applicability.
	Decide	d	P	The document does not contain MOPS and there are limitations in terms of drone size and airspace applicability.
	Command	d		
	Execute	d		
	F. Loop	d		
	Integrity	d		

Notes:

General and applicability:

This document contains the OSED for the Phase 2 MOPS for DAA systems used in aircraft transiting and performing extended operations in Class D, E, and G airspace along with transiting Class B and C airspace. It includes equipment to enable UAS operations in terminal airspace during approach and departure in Class C, D, E, and G airspace, and off-airport locations. It does not apply to small UAS operating in low-level environments (below 400') or other segmented areas. Likewise, it does not apply to operations in the visual traffic pattern of an airport or surface operations.

Detect:

Operational requirements include the detection of both cooperative and non-cooperative aircraft in the relevant airspace. MOPS will address specific detection performance requirements.

Decide:

General requirements on how information should be displayed to remote pilot on the GCS are provided.

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Activity diagrams are provided for different situations, depicting the notional way that activities unfold during an encounter. Precise responsibilities for remote pilot and other stakeholders (e.g. ATC) are outlined.

Command:

No performance requirements are provided on the C2 Link. However, the OSED takes into account the possibility to have both terrestrial and satellite communication.

Execute:

No specific flight dynamics performance requirements are provided.

Feedback Loop:

No specific requirements are provided.

In conclusion the OSED must be complemented by MASPS/MOPS to be an effective means of compliance with SORA Arc-d requirements.

Table 102

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
RTCA DO-366: Minimum Operational Performance Standards for Air To Air Radar for Detect And Avoid Systems	Detect	d	P	The document covers the Detect functionality but there are some limitations in terms of airspace applicability (i.e. VLL not covered). See notes for more details.
	Decide	d		
	Command	d		
	Execute	d		
	Feedback Loop	d	P	The document covers the Detect functionality but there are some limitations in terms of airspace applicability (i.e. VLL not covered). See notes for more details.

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	Integrity	d	P	The MOPS assume that all equipment that supports or sends data to the DAA system is designed with a design assurance level appropriate for the intended function. Other standards (e.g. RTCA DO 178C for software) can be used to ensure that the system meets such requirement.

Notes:

General and applicability:

This document contains Phase I Minimum Operational Performance Standards (MOPS) for the air-to-air radar for Detect and Avoid (DAA) systems implemented in Unmanned Aircraft (UA) transitioning to and from Class A or special use airspace, traversing Class D, E, and G airspace in the National Airspace System (NAS). It does not apply to small Unmanned Aircraft Systems (sUAS) operating in low-level environments (below 500') or other segmented areas. Likewise, it does not apply to operations in the Visual Flight Rules (VFR) traffic pattern of an airport. These standards specify the radar system characteristics that should be useful for designers, manufacturers, installers and users of the equipment.

This document sets performance standards for the air-to-air radar as part of a DAA system. Separate MOPS (i.e. DO 365) were developed for the DAA systems.

Detect:

The radar is able to detect non-cooperative intruders with a minimum Radar cross section of a human and is not able to detect any hovering or stationary object as it depends on the radar cross section as well as the level of ground clutter. Therefore the system should be able to detect manned aircraft in the operational area but not small drones.

Decide:

Radar output shall be processed by a DAA system (e.g. DO 365).

Command:

No requirements on the link performance as the focus is on radar performance.

Execute:

No requirements on performance are given.

***Feedback Loop*:**

The update rate is 1 Hz.

Table 103

Standard title	Function	Arc	Coverage	Gaps (Requirements not covered)

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			(P-Partial coverage, F-Full coverage)	
RTCA DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	Detect	d	P	Only DAA functions to manage cooperative intruders are provided.
	Decide	d	P	
	Command	d		
	Execute	d		
	Feedback Loop	d	P	Only DAA functions to manage cooperative intruders are provided.
	Integrity	d	F	An operational hazard analysis is provided as well as a fault tree analysis to allocate safety objectives.

Notes:

General and applicability:

This document contains MASPS for Aircraft Surveillance Applications (ASA). In particular it provides requirements for all subsystems supporting the operational application of ASA (e.g. ADS-B). This standard specifies characteristics that should be useful to designers, installers, manufacturers etc for systems intended for operational use in the US National Airspace System.

Manned aviation is the target although some requirements and functions may be applied also for UAS.

Detect:

The surveillance function is performed by ADS-B/TIS-B that is only able to detect cooperative traffic.

Decide:

Some functions aimed at improving pilot situational awareness of proximate traffic. The Cockpit Display of Traffic Information (CDTI) is the flight crew interface where alerts, graphical guidance etc. are displayed.

Command:

No reference to C2 Link as the standard is developed for manned aviation applications.

Execute:

No reference on aircraft performance dynamics.

***Feedback Loop*:**

Requirements on latency as well as on update intervals are provided for each function.

This standard is not specific for UAS and does not cover all SORA requirements. Therefore it is better to take as reference standards on DAA systems.

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Table 104

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
RTCA DO-376: Minimum Operational Performance Standards for Airborne Collision Avoidance System Xu (ACAS Xu)	Detect	d	P	The MOPS cover all the functionalities but there are some limitations, mainly in terms of airspace applicability. See notes.
	Decide	d	P	
	Command	d	P	
	Execute	d	P	
	Feedback Loop	d	P	
	Integrity	d	P	The document requires compliance with other standards for design assurance (i.e. DO 178 C, DO 254).

Notes:

General and applicability:

This document contains the MOPS for ACAS Xu concept. ACAS Xu is designed for vehicles with new surveillance technologies and different performance characteristics with respect to traditional manned aviation such as UAS.

It is a complete Detect and Avoid (DAA) solution that provides RWC in compliance with the SC 228 DAA Minimum Operational Performance Standards (MOPS), and CA in compliance with the Minimum Aviation System Performance Standards (MASPS) for the Interoperability of Airborne Collision Avoidance Systems.

In addition to vertical logic, XU also supports horizontal logic, intelligently switching between the two based on a variety of factors to resolve encounters more effectively.

This ACAS Xu concept is developed for the NAS (National American Airspace), possibly overcoming the limitations of DAA Phase 1 and Phase 2 developed by RTCA.

The ACAS Xu concept has the following applicability range:

Environment

- Lower-risk airspace:
  - Infrequent manned traffic areas
  - Low probability of encounters with manned aircraft o Away from approach/departure paths near airports during known active times

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    - Below typical transit altitudes for IFR flights

- Classes G and E airspace (below about 1,200 AGL), Class B, C, D (below about 400/500 AGL, below obstacle clearance surface, within LAANC designated areas)
    - No ATC separation services o ATC coordination/approval in Classes B, C, and D
- Mixed cooperative and non-cooperative traffic – VFR and IFR manned traffic
    - May include rotorcraft, crop dusters, ultralights, LSA/small GA fixed-wing
    - No commercial fixed wing traffic

- Includes but is not limited to "All cooperative", low-altitude airspace (e.g., Mode C veil in 2020)
- Day and night-time; VMC and IMC

Operations

- Applicable to avoidance of manned aircraft

o No UA-to-UA (reserved for future efforts)
o The UA will take into consideration the same right-of-way rules as manned aircraft with regards to collision avoidance and right of way
o Technical capabilities may function in manner that would also avoid some UAs but this will not drive requirements

- No requirements for terrain/obstacle/airspace avoidance function (e.g., minimum separation from obstacles)

o Requirements will address the effects of any terrain/obstacles/airspace avoidance functions on the DAA system ù

- No birds or natural hazard (e.g., weather, clouds) avoidance requirements

Aircraft

• Any smaller UA less than 254 lbs. (weight of ultralight aircraft)
• Operating at airspeeds below 100kts
• Fixed-wing, rotorcraft, hybrid transitional categories

Detect:

Surveillance inputs include ADS-B, Mode S, Mode C, and non-cooperative surveillance.

Decide:

The system is capable of issuing vertical guidance and horizontal guidance for both cooperative and non-cooperative traffic and the logic can be tuned to accommodate a wide variety of UAS vehicle performance.

Command:

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The XU MOPS specify requirements (e.g. latency, vertical acceleration) for response to XU CA manoeuvres. If a platform cannot meet those requirements with manual response, then it must implement automatic response.

Execute:

Performance requirements in terms of turn rate and vertical manoeuvres are specified. The same requirements of DAA MOPS are retained.

***Feedback Loop*:**

Requirements on surveillance update rates are provided.

In conclusion the ACAS Xu concept offer an alternative to traditional DAA concept (RWC plus TCAS CA). However, TCAS it is designed for large, manned, turbine-powered transport aircraft and could be applicable for large UAS once compliance with interoperability requirements is demonstrated. XU offers increased flexibility for other potential future changes (such as horizontal manoeuvres or decreased/different climb rates than those assumed by TCAS II), increased adaptability to new surveillance inputs, reduced collision risk (compared to TCAS II), and the ease of extending an interoperable concept to new user classes.
In addition the Xu implementation is suitable (but not limited to) also for small drones operating at VLL.

Table 105

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
EUROCAE ED-271: Minimum Aviation System Performance Standard (End-to-end Requirements at system level) for DAA of IFR Flights in class A-C airspace	Detect	d	P	The standard covers all the functional requirements but there are some limitations in term of drone size and airspace applicability (See notes).
	Decide	d	P	
	Command	d	P	
	Execute	d	P	
	F. Loop	d	P	
	Integrity	d	P	Safety requirements in terms of maximum allowable failure rate are provided. To comply with requirements on software design assurance, it is necessary to refer also to EUROCAE ED 12C/DO 178C.

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Notes:

General and applicability:

The document contains the Minimum Aviation System Performance Standards (MASP) for DAA in airspace classes A, B, C under IFR.

Ground based DAA is not covered.

***Detect*:**

The document states that the DAA system shall detect cooperative and non-cooperative intruders in prescribed environmental conditions.

Decide:

The MASPS contain only high-level requirements on decide criteria, proposed manoeuvres and interface with remote pilot.

Command:

Minimum requirements on round trip latency of the C2 Link are provided. C2 link requirements are given at RLP[2] (Required Link performance), i.e. in terms of availability, transaction time, continuity and integrity).

Execute:

Requirements on flight dynamics performance are provided in terms of rate of climb, descent, banking turn etc.

Feedback Loop:

Specifications on intruder data update are provided.

In conclusions, MASPS are technology/solution agnostic as they only define system requirements and should be complemented by MOPS to define details at component level.

The current version of the MASPS does not include detection of adverse weather conditions, obstacles, terrain etc. but it is announced that future revision of the document will also address these issues[3].

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[2] RLP is a term proposed by JARUS and adopted by ICAO RPAS panel.

[3] It should be noted that SORA TMPR requirement only deal with manned traffic detection.

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Table 106

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
EUROCAE ED-258: Operational services and environment description (OSED) for detect and avoid in class D-G airspaces under VFR/IFR	Detect	b,c,d	P	The document is still at OSED level. MASPS/MOPS required to comply with Arc-d. However, the standard only applies to a given portion of airspace.
	Decide	d	P	See notes.
	Command	d		
	Execute	d		
	F. Loop	d		
	Integrity	d		

Notes:

General and applicability:

The purpose of this Operational Services and Environment Definition (OSED) is to provide a basis for assessing and establishing operational, safety, performance, and interoperability requirements for the Detect And Avoid Remain Well Clear (RWC) and Collision Avoidance (CA) functions in Class D-G Airspaces. Until a new definition for RPAS Flight rules is agreed at international level, both Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) operation are in scope of the DAA functions described in this OSED.

Flight phases on ground or near ground e.g. take-off, landing, initial climb and final descent are formally excluded although the DAA system is expected to operate in these regions possibly with reduced performance.

***Detect*:**

The document states that both cooperative and non-cooperative traffic shall be detected as both traffic could be present in D-G airspace classes.

Decide:

Although general requirements on HMI are included, conditions for which an advisory alert is raised to the RP are not included in this OSED but will be part of interoperability MASPS activity of this DAA system.

Command:

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No performance requirement are provided for the C2 Link (it is only recognised that C2 Link is an essential element to support DAA functions).
Execute:
No specific flight dynamics performance requirements are provided.
Feedback Loop:
No specific requirements are provided.
In conclusion this OSED is the starting point for future development of MASPS. It can be used as reference for operators flying in the relevant conditions to determine how to equip the drone to effectively detect the traffic present in the area.

Table 107

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
EUROCAE ED-267: Operational Services and Environmental Description for DAA in Very Low-Level Operations	Detect	d	P	The document is still at OSED level. MASPS/MOPS required to comply with Arc-d. However, the standard only applies to a given portion of airspace.
	Decide	d	P	See Notes
	Command	b,c,d		
	Execute	b,c,d		
	F. Loop	b,c,d		
	Integrity	d		

Notes:
General and applicability:
This document provides the Operational Services and Environment Definition (OSED) for the Detect and Avoid (DAA) capabilities to support very low level (VLL) operations conducted by unmanned aircraft systems (UAS) in the Specific and Certified Category. All phases of flight are covered and both day and night conditions. Adverse weather, operations in vicinity of airports, obstacles and wildlife are taken into account.
This OSED is the baseline for the development of MASPS and MOPS.

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Detect:
Although not referring to specific equipment, the OSED provide guidance on the type of traffic that could be present at VLL, including manned and unmanned aircraft.
Detection of hazards can be achieved through on-board sensors, ground based sensors, databases or U-Space services.
Decide:
The document defines the DAA functionality of providing situational awareness and alerts to the remote pilot as well as guidance for avoidance manoeuvres. However specific requirements will be provided in the MASPS/MOPS. In addition, clear VLL flight rules still have to be defined.
Command:
No performance requirements are provided on the C2 Link. However the OSED takes into account the possibility to have both RLOS and BRLOS (terrestrial or satellite) communication.
Execute:
No specific flight dynamics performance requirements are provided.
Feedback Loop:
No specific requirements are provided.

In conclusion the OSED must be complemented by MASPS/MOPS to be an effective means of compliance with SORA Arc-d requirements. Anyway, it could be used as guidance for lower Air Risk classes for the *Detect* functionality, in order to proper select the tactical mitigation that is more effective in the target environment.

Table 108

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
EUROCAE ED-265: MOPS C2 Link (SATCOM)	Detect	d		
	Decide	d		
	Command	d	P	Terrestrial link is not covered.
	Execute	d		
	F. Loop	d	P	MOPS only cover satellite link.
	Integrity	d		

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Notes:
General and applicability:
This document defines MOPS for C2 Link relying on near-geosynchronous (GEO) orbit systems operating in the 5030-5091 MHz frequency band (satellite link).
Detect:
The standard does not address aircraft detection issues.
Decide:
The standard does not address criteria to take decisions with the aim to avoid collisions.
Command:
The standard estimates performance (in terms of latency) for the execution of manoeuvres both in manual and automatic mode.
Execute:
No requirements on aircraft flight dynamics.
Feedback Loop:
Estimation on situational awareness data (rates and sizes) to support DAA function are provided.

In conclusion the standard addresses C2 Link (satellite link) performance to support DAA functions.

3.5.4 Gaps

3.5.4.1 Summary

Table 109 Gap Summary – Tactical Mitigations - BVLOS

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of standards (i.e. MOPS) on DAA for small drones.	-11	It is recommended to develop standards for DAA on small drones operating at VLL, mainly for safety and commercial reasons. It is expected that this gap will be filled by EUROCAE WG 105/SG 13 (including RWC, terrain, obstacles, etc.), as well as by ASTM RTCA with the ACAS sXu MOPS.

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2	Lack of standards (i.e. MOPS) for small drones above VLL.	-9	RTCA standards cover DAA requirements for OPS above VLL but are suitable only for large drones. It is therefore recommended to develop standards for DAA above VLL for small drones. This is not a typical operational situation (as most small drones will be operated at VLL) but in principle it is allowed by SORA and tactical mitigations are needed. This gap may be filled by RTCA through the planned ACAS sXu MOPS.

3.5.4.2 Details

Table 110

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of standards (i.e. MOPS) on DAA for small drones at VLL	Safety (3)	Very High	Reliable DAA solutions are needed to avoid conflict between unmanned and manned traffic. Although small drones have a very limited size and mass, several studies indicate that effect of possible collisions may be catastrophic, resulting in serious damages [1].	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	High	The absence of recognised DAA solutions makes it impossible to carry out operations associated to Arc-d. This leads to the necessity to segregate airspace (which has a cost and is time consuming for operators).	-1	-2
		Environmental Impact (1)	Bad	DAA concept for VLL may deal with avoidance of wildlife or protected areas.	-2	-2
		Impact on EU Industry competitiveness (1)	Negative	As outlined in [4], European players are expected to play a key role in developing and commercialising drone technologies compatible with future airspace management requirements, including detect and avoid technology.	-1	-1
		Social Acceptance (1)	No impact	Until reliable DAA solutions are developed, certain types of operations will not be authorised by Authorities, but no particular societal concern is expected.	0	0
Total Weighted Score						-11

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Table 111

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards (i.e. MOPS) for small drones above VLL	Safety (3)	Very High	Reliable DAA solutions are needed to avoid conflict between unmanned and manned traffic. Although small drones have a very limited size and mass, several studies indicate that effect of possible collisions may be catastrophic, resulting in serious damages	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	High	The absence of recognised DAA solutions makes impossible to carry out operations associated to Arc-d. This leads to the necessity to segregate airspace (which has a cost and is time consuming for operators).	-1	-2
		Environmental Impact (1)	No impact		0	0
		Impact on EU Industry competitiveness (1)	Negative	European players are expected to play a key role in developing and commercialising drone technologies compatible with future airspace management requirements, including detect and avoid technology. Compliance with this standard may represent one of the pillars for safe integration of drones in the civilian airspace and may enable complex operations (such as cargo), potentially expanding business of several companies.	-1	-1
		Social Acceptance (1)	No impact	Until reliable DAA solutions are developed, certain types of operations will not be authorised by Authorities, but no particular societal concern is expected.	0	0
Total Weighted Score						-9

3.5.5 Conclusions and Recommendations

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Several standards dealing with DAA have been or are being developed, however none of the standards fully cover SORA TMPR, due to each standard being targeted to a specific operational environment.

RTCA MOPS for DAA Phase 1 are already published and partially cover all the SORA requirements, as the DAA concept does not support VLL operations and is not applicable for small UAS (i.e. UAS with MTOM below 25 kg). Phase 2 should extend the scope of Phase 1 to wider portions of airspace (not VLL) and supporting also satellite C2 Link.

The new Acas Xu concept, for which RTCA has already published a draft of the MOPS, should be more flexible and applicable also for smaller UAS. In addition to vertical logic, XU also supports horizontal logic, intelligently switching between the two based on a variety of factors to resolve encounters more effectively.

As a general remark, however, it must be noticed that the RTCA DAA concept is developed to support operations in the US National Airspace System (NAS).

In EUROCAE some activities are ongoing to develop MOPS for DAA in different airspace classes. Currently the draft of the MASPS for DAA in A-C airspace are available as well as OSED for DAA in Class D-G and OSED for DAA at VLL. Therefore, with respect to RTCA, the VLL airspace will be covered, addressing the needs of most UAS flying BVLOS in the Specific Category. Furthermore, it is noted that EUROCAE is working on a standard to address sUAS in VLL.

With respect to RTCA, the scope of EUROCAE DAA seems to be wider although MOPS are not available yet and full coverage of SORA TMPR cannot be claimed. One important element is the fact that, in order to be fully comply with SORA TMPR (i.e. “Command” and “Feedback loop” requirements), standards on DAA shall define also performance on the C2 Link (mainly latency) to support its functions. This is already considered in the RTCA Phase 1 where MOPS for C2 Link are mentioned as reference and performance requirements reported in a dedicated Appendix.

It is worth noting that compliance with MASPS/MOPS is only required for Arc-d. Mandating also operators flying in Arc-b or Arc-c to comply with these MOPS would be too conservative (MOPS usually represent the basis for TSO/ETSO certification processes). To ensure compliance with lower risk classes it is suggested to monitor ASTM activities related to DAA which are producing standards “ad hoc” for Arc-b and Arc-c, possibly prescribing less demanding requirements with respect to the traditional MOPS. Currently, the full ASTM documents were not available to the consortium.

In conclusion, although some requirements are not covered at present, it is expected that the on-going and planned standardisation processes should fulfil all the TMPR requirements in SORA. Moreover, it is recognised that there is a lack of MOPS for DAA applicable for small drones. However, this gap could be filled by EUROCAE within WG 105. From this analysis it emerges that DAA requirements should be adequately covered by standards in the next years. However, aspects such as cost of compliance to DAA standards should be considered.

- DO-365 and ED-271 have potentially a full coverage of the BVLOS TMPR requirements for all residual Air Risk levels but:

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- Limited scope (large UAS)
- High cost of compliance

- Other more specific standards can be used to demonstrate compliance to the requirements for specific DAA functions (e.g. DO-366: MOPS for Air To Air Radar)
- The need to develop dedicated standards for small drones operating at VLL and above might be solved by upcoming EUROCAE MOPS on DAA at VLL and ASTM & RTCA ACAS-sXu MOPS.
- These activities on DAA will be monitored for the development of guidance and standards more tailored to small drones.
- It is noted that EUROCAE and RTCA intend to harmonize respective plans in this area.

Table 112 Recommended Standards

Functions	Arc	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
All	Arc-a	N/A	NO STANDARDS REQUIRED			
	Arc-b	Partial	F3442 - Detect and Avoid performance Requirements	The document potentially covers the requirements however the full draft was not available to the consortium. It is advised to include WK62669 - Detect and Avoid Testing Requirements, which is still in the drafting phase.	6	Lack of standards (i.e. MOPS) on DAA for small drones. Lack of standards (i.e. MOPS) for small drones above VLL.
			ED 258 Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR	MASPS/MOPS are needed to fully comply with SORA requirements. In addition, this standard only covers a portion of airspace (D-G).	5	
			ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	MASPS/MOPS are needed to fully comply with SORA requirements. Only applicable to VLL operations **Not applicable to Feedback Loop and Integrity Functions**	8	

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	Arc-c	Partial	F3442 - Detect and Avoid performance Requirements	The document potentially covers the requirements however the full draft was not available to the consortium. It is advised to include WK62669 - Detect and Avoid Testing Requirements, which is still in the drafting phase.	6	
			DO-289 Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	Aimed at manned aviation **Not applicable to Command and Execute Functions**	3	
			ED 258 Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR	MASPS/MOPS are needed to fully comply with SORA requirements. In addition, this standard only covers a portion of airspace (D-G).	5	
			ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	MASPS/MOPS are needed to fully comply with SORA requirements. Only applicable to VLL operations **Not applicable to Feedback Loop and Integrity Functions**	8	
	Arc-d	Partial	DO-365: MOPS for Detect and Avoid (DAA) Systems-Phase 1	Not applicable to all categories of drones (SWAP) Cost of compliance for small drones is estimated to be high	2	
			ED-267 Operational Services and Environmental Description for DAA in Very Low-level Operations	MASPS/MOPS are needed to fully comply with SORA requirements. Only applicable to VLL operations **Not applicable to Feedback Loop and Integrity Functions**	8	
			ED-271: MASPS for Detect & Avoid [Traffic] in Class A-C airspaces under IFR	Scope is limited in terms of operational applicability (e.g. only IFR traffic)	2	

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			DO-366 Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance VLL not covered	**Not applicable to Decide, Command and Execute Functions**	3	
			DO-289 Minimum Aviation System Performance Standards for Aircraft Surveillance Applications	Aimed at manned aviation **Not applicable to Command and Execute Functions**	3	
			ED-265 Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)	Does not cover terrestrial link **Not applicable to Detect, Decide and Integrity Functions**	4	

3.6 *OSO 01* - Ensure the operator is competent and/or proven

3.6.1 Requirement Description

Table 113 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The applicant is knowledgeable of the UAS being used and as a minimum has the following relevant operational procedures: • checklists, • maintenance, • training, • responsibilities, and associated duties.
	Medium	Same as Low.

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	High	In addition, the applicant has an organization appropriate[1] for the intended operation. Also, the applicant has a method to identify, assess, and mitigate risks associated with flight operations. These should be consistent with the nature and extent of the operations specified. *(1) For the purpose of this assessment, "appropriate" should be interpreted as commensurate/proportionate with the size of the organization and the complexity of the operation.*

Table 114Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The elements delineated in the level of integrity are addressed in the ConOps.
	Medium	Prior to the first operation, a competent third party performs an audit of the organization.
	High	The applicant holds an Organizational Operating Certificate or has a recognized flight test organization. In addition, a competent third party recurrently verifies the operator competences.

3.6.2 Summary

Table 115 OSO 1 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity					
New Specification for Operation over People	ASTM	WK52089		P	P
Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)	ASTM	F3178-16		P	P
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	P	P	P
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	P
Assurance					
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P
Standard Practice for Independent Audit Program for Unmanned Aircraft Operators	ASTM	F3364-19		P	P

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New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P	P

Table 116 OSO 1 Other standards to be considered in future iterations (not yet available)

Standard Title	SDO	Doc. Reference	Notes
UAS Operator Compliance Audits	ASTM	WK62731	Ballot Item Approved as F3365-2019 and Pending Publication
Common operator qualifications	SAE	ARP XXX	Document planned
Operation of Aircraft	ICAO	Annex 6-Part IV	Part IV not yet in force or published

3.6.3 Integrity Coverage Detail

Table 117

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Specification for Operation over People	ASTM	WK52089		P	P	This standard is applicable for operations of small UAS over people.
Notes: This standard focuses on operational risk assessments and risk mitigations for operations over people. It also focuses on parachute systems, airbags, human injury assessments and frangible design. The document is unavailable hence the extent of coverage cannot be fully assessed.						

Table 118

Standard Title	SDO		Criterion 1	Gaps

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		Doc. Reference	L	M	H	
Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)	ASTM	F3178-16		P	P	This standard does not cover the requirement about operator competency that should be adequate for the operation.

Notes:
This practice is based on a traditional approach considering probability and severity: it focuses on preparing operational risk assessments (ORAs) to be used for supporting small unmanned aircraft systems (sUAS) (aircraft under 55 lb (25 kg)) design, airworthiness, and subsequent operational applications to the civil aviation authority (CAA). The sections about design and airworthiness are out of scope of OSO #1. Nevertheless this standard could provide useful guidance to identify, assess, and mitigate risks associated with flight operations.

Table 119

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	P	P	P	This standard defines the requirements (ie. a template) for a General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS). The standard addresses the requirements and/or best practices for documentation and organization of a professional operator (i.e., for compensation and hire).

Notes:

This standard is potentially suitable to comply with the requirements of OSO #1 at all level of robustness. The coverage is set as partial since the standard does not provide guidance on what to include in the different sections of the Manual to comply with different levels of robustness. Nevertheless, a Manual prepared according to this standard is expected to include at least all required information for a Low Level of Robustness.

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Table 120

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	P	The standard provides high-level guidance.

Notes:
This document specifies the requirements for safe commercial UAS operations. With respect to the UAS Operator, this standard provides a list of the documents that an operator shall prepare to demonstrate that he is competent and/or proven (i.e. OSO #1 requirements). However, it does not contain detailed guidance on how to prepare such documents. It is expected that ISO standards will refer to other SDO's standards for guidelines on how to develop specific items. Nevertheless, an operator that is certified according to this ISO standard by an ISO notified body, can certainly claim to fulfil OSO #1 at all levels of robustness.

3.6.1 Assurance Coverage Detail

Table 121

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P	The standard provides high-level guidance.

Notes:
This document partially covers OSO #1 assurance requirements, as compliance to this standard could be used to as the basis for an audit from an ISO notified body.

Table 122

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Standard Practice for Independent Audit Program for Unmanned Aircraft Operators	ASTM	F3364-19		P	P	This document is addressed to auditors rather than the audited operator.

Notes:

This practice establishes the minimum set of requirements for an independent audit program for unmanned aircraft system operators. The intended use is to provide minimum requirements for an initial assessment of operators bringing a new aircraft model or service to market, or for periodic review of an existing operator's operations. Compliance to this practice would ensure that the audit program and those who execute it meet the consensus set of minimum requirements and qualifications.

Table 123

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P	P	This standard defines the requirements (ie. a template) for a General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS). The standard addresses the requirements and/or best practices for documentation and organization of a professional operator (i.e., for compensation and hire).

Notes:

The intent is for this standard to support professional entities that will receive operator certification by a CAA, and provide standards of practice for self- or third-party audit of operators of UAS.

3.6.2 Gaps

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3.6.2.1 Summary

Table 124 Gap Summary - OSO 1

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.	-4	It is recommended to develop a standard/guideline to define minimum requirements for structure and organisation operators depending on the size of the organization and the complexity of the operations.

3.6.2.2 Details

Table 125

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.	Safety (3)	High	Each company should have a structure, consistent with the level of activities and business. The aviation companies should have a structure with, as minimum, specific job positions for operational, logistic and safety matters. The absence of evidence on requirements for operators' structure may create atypical roles and responsibilities with unbalanced working load. Of course, the issue is more sensitive for medium/large companies. One of the more critical aspects is the responsibility of SMS.	-1	-3

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		Cost of compliance to the requirement with a lack standard (2)	Low	No relevant extra costs to implement a company structure in absence of a specific standard. On the opposite, when the company is well organised and managed, financial benefit may arise.	+1	+2
		Environmental Impact (1)	Bad	The absence of requirements regarding the structure may be sensitive for environmental company policy	-2	-2
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	A structured company, with specific roles and addressed responsibilities is more appreciated	-1	-1
Total Weighted Score						**-4**

3.6.3 Conclusions and Recommendations

In order to demonstrate compliance to OSO #1 operators might use different standards already published or under development. While covering the objectives expressed in OSO #1 requirements, ISO Standard 21384-3: Unmanned aircraft systems -- Part 3: Operational Procedures only provides high-level guidance, lacking technical details and details on minimum requirements for organizations in terms of structure, post-holders. The document could be considered the foundation to define high level requirements. On top of this, other standards dealing with more detailed aspects could be used (e.g. for Risk Assessment or the development of the Operations Manual).

The gap identified is related to the absence of specific standards or guidelines to define what the minimum structure of an operator should be in relation to its size and the complexity of the operation.

Moreover, there is a need for training at operator level, the details of which are addressed in OSO #9.

Table 126 Recommended Standards - Integrity

Integrity

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Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Partial	ISO 21384-3: Operational Procedures	It provides high level guidance	2	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.
	Medium High	Partial	ASTM F3178-16: Standard practice for operational risk assessment of small unmanned aircraft systems (sUAS	It only convers the requirement related to Risk Assessment	3	
		Partial	ISO 21384-3: Operational Procedures	It provides high level guidance	4	

Table 127 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARD REQUIRED			
	Medium High	Partial	ISO 21384-3: Operational Procedures	It could be used as the basis for audit by ISO notified bodies	4	
		Partial	ASTM F3364-19*: Standard practice for independent audit program for unmanned aircraft operators	*When Article 69 of 2018/1139 will be implemented as it would require the establishment of qualified entities. The standard is addressed to auditors	4	

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3.7 *OSO 02* – UAS manufactured by competent and/or proven entity

3.7.1 Requirement Description

Table 128 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	As a minimum, manufacturing procedures cover: • specification of materials • suitability and durability of materials used, • Processes necessary to allow for repeatability in manufacturing and conformity within acceptable tolerances.
	Medium	Same as Low. In addition, manufacturing procedures also cover: • configuration control, • verification of incoming products, parts, materials, and equipment, • identification and traceability, • in-process and final inspections & testing, • control and calibration of tools, • handling and storage, • Non-conforming item control.
	High	Same as Medium. In addition, the manufacturing procedures cover at least: • manufacturing processes, • personnel competence and qualification, • supplier control.

Table 129 Assurance Requirements' Description

Criterion	Robustness	Description

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Criterion #1	Low	The declared manufacturing procedures are developed to a standard considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	Medium	Same as low. In addition, evidence is available that the UAS has been manufactured in conformance to its design.
	High	Same as medium. In addition: • manufacturing procedures; and • the conformity of the UAS to its design and specification are recurrently verified through process or product audits by a competent third party (or competent third parties).

3.7.2 Summary

Table 130 OSO 2 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity/Assurance					
Quality management systems — Requirements	ISO	9001:2015	F	F	F
Quality Management Systems - Requirements for Aviation, Space and Defence Organizations	EN	9100:2018	F	F	F
Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	ASTM	F3003-14	F	F	P
Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System	ASTM	F2972 - 15	F	F	F
Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)	ASTM	F2911-14e1	P		
New Practice for Compliance Audits to ASTM Standards on Unmanned Aircraft Systems	ASTM	WK62731	(P)	(P)	(P)

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3.7.1 Coverage Detail

Table 131

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Quality management systems — Requirements	ISO	9001:2015	F	F	F	The standard is generically defining how to establish a quality management system but there are no details on how to do such thing for the manufacturing of UAS.
Notes: The standard is generically defining how to establish a quality management system but there are no details on how to do such thing for the manufacturing of UAS. Nevertheless, a quality system compliant with this standard is a valid starting point to demonstrate compliance to OSO #2.						

Table 132

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Quality Management Systems - Requirements for Aviation, Space and Defence Organizations	EN	9100:2018	F	F	F	The standard is generically defining how to establish a quality management system but there are no details on how to do such thing for the manufacturing of UAS.
Notes: This standard is intended for the specific implementation of the ISO 9001 standards in the aerospace industry. Nevertheless, a quality system compliant with this standard is considered sufficient to demonstrate compliance to OSO #2 at all levels of robustness.						

Table 133

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	ASTM	F3003-14	F	F	P	It is only applicable for UAS with MTOM of less than 25 kg.

Notes:
This specification establishes the quality assurance requirements for the design, manufacture, and production of a small unmanned aircraft system (sUAS). It is intended for all sUAS that are permitted to operate over a defined area and in airspace defined by a nation's governing aviation authority (GAA). Unless otherwise specified by a nation's GAA, this specification applies only to UA that have a maximum take-off gross weight of 55 lb/25 kg or less.
This standard defines the quality assurance requirements for the design, manufacture, and production of a small unmanned aircraft system (sUAS). In SAIL IV does not conform with supplier control.

Table 134

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Practice for Compliance Audits to ASTM Standards on Unmanned Aircraft Systems	ASTM	WK62731	(P)	(P)	(P)	It is understood that the standard may be useful for internal quality control in design and production, although the standard is only planned

Notes:
This practice establishes the minimum set of requirements for auditing programs, methods, and systems; the responsibilities for all parties involved; and qualifications for entities conducting audits against ASTM International standards on unmanned aircraft systems (UAS).
This practice provides requirements to enable consistent and structured examination of objective evidence for compliance that is beneficial for the UAS industry and its consumers. It is the intent of this practice to provide the necessary minimum requirements for organizations to develop audit programs and procedures.

Table 135

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)	ASTM	F2911-14e1	P			The standard is only applicable to UAS with MTOM less than 25 kg manufactured according to the Specifications identified in ASTM F2910.

Notes:
This standard defines the production acceptance requirements for a small unmanned aircraft system (sUAS).
This standard is applicable to sUAS that comply with design, construction, and test requirements identified in Specification F2910. No sUAS may enter production until such compliance is demonstrated.

Table 136

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System	ASTM	F2972 - 15	F	F	F	No specific requirements related to UAS manufacturing procedures.

Notes:
This specification establishes the minimum requirements for a quality assurance system for manufacturers of Light Sport Aircraft or Light Sport Aircraft kits, or both. Therefore, it is not specific for UAS.

3.7.2 Gaps

3.7.2.1 Summary

Table 137 Gap Summary - OSO 2

Gap	Gap Description	Total Weighted Score	Conclusion Recommendation

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1	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.	+2	The development of a dedicated standard might not be needed, but manufacturers should at least implement a quality management system compliant with ISO 9001 or (ASTM F3003-14 for small UAS), which is compliant with the requirements defined by OSO #2 at the required level of integrity.

3.7.2.2 Details

Table 138

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.	Safety (3)	Medium	The absence of a specific standard might not be critical if this is compensated by the implementation of an adequate generic quality management system according to one of the available standards (e.g. ISO 9001 or EN 9100)	0	0
		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of compliance to the requirements of OSO #2 in absence of a specific standard is estimated as low, given that the manufacturer will likely implement in any case a quality management system for commercial reasons.	+1	+2
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Neutral	No impact	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**+2**

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3.7.3 Conclusions and Recommendations

Considering the standards already available and those under development, the coverage of OSO #2 requirements seems to be adequate. However, a standard addressing specifically UAS manufacturing processes and quality assurance, that is applicable for any UAS does not exist. This could lead to a lack of uniformity in the manufacturing processes, but this is not expected to impact safety in a significant way.

Table 139 Recommended Standards

Integrity/Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low Medium	Partial	ASTM F3003-14: Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg.	11 (low) 13 (med)	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.
			ASTM F2911-14e1 Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg developed according to ASMT F2910.	5 (low)	
		Full	EN 9100:2018: Quality Management Systems – Requirements for Aviation, Space and Defence Organizations	No specific requirements related to UAS manufacturing procedures.	9 (low) 11 (med)	

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			ASTM F2972-15: Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System	No specific requirements related to UAS manufacturing procedures.	5 (low) 7 (med)	
			ISO 9001:2015 Quality management systems – Requirements	Only high level guidance. No specific requirements related to UAS manufacturing procedures.	10 (low) 12 (med)	
	High	Partial	ASTM F3003-14 - Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg.	9	
		Full	ISO 9001:2015 Quality management systems – Requirements	Only high level guidance. No specific requirements related to UAS manufacturing procedures.	14	
			EN 9100:2018 Quality Management Systems - Requirements for Aviation, Space and Defence Organizations	No specific requirements related to UAS manufacturing procedures.	11	

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3.8 *OSO 03* – UAS maintained by competent and/or proven entity

3.8.1 Requirement Description

Table 140 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion 1	Low	• The UAS maintenance instructions are defined and when applicable cover the UAS designer instructions and requirements. • The maintenance staff is competent and has received an authorisation to carry out UAS maintenance • The maintenance staff use the UAS maintenance instructions while performing maintenance.
	Medium	Same as Low. In addition: • Scheduled maintenance of each UAS is organised and in accordance with a Maintenance Programme. • Upon completion, the maintenance log system is used to record all maintenance conducted on the UAS including releases. A maintenance release can only be accomplished by a staff member who has received a maintenance release authorization for that particular UAS model/family.
	High	Same as Medium. In addition, • the maintenance staff works in accordance with a maintenance procedure manual that provides information and procedures relevant to the maintenance facility, records, maintenance instructions, release, tools, material, components, defect, deferral…

Table 141 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion 1 (procedures)	Low	• The maintenance instructions are documented. • The maintenance conducted on the UAS is recorded in a maintenance log system. • A list of maintenance staff authorised to carry out maintenance is established and kept up to date.

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	Medium	Same as Low. In addition: • The Maintenance Programme is developed in accordance with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • A list of maintenance staff with maintenance release authority is established and kept up to date.
	High	The maintenance programme and the maintenance procedures manual are validated by a competent third party.
Criterion 2 (Training)	Low	A record of all relevant qualifications, experience and/or trainings completed by the maintenance staff is established and kept up to date.
	Medium	Same as Low. In addition: • Initial training syllabus and training standard including theoretical/practical elements duration, etc. is defined and commensurate with the authorization held by the maintenance staff. • For staff holding a maintenance release authorisation, the initial training is specific to that particular UAS model/family. All maintenance staff have undergone initial training.
	High	Same as medium. In addition: • A programme for recurrent training of staff holding a maintenance release authorisation is established; and • This programme is validated by a competent third party.

3.8.2 Summary

Table 142 OSO 3 Standards' effectiveness in fulfilling the requirement

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness Criterion 2		
			L	M	H	L	M	H
Integrity								
Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	ASTM	F2483 - 18		F				
Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	ASTM	F2909-19		F				

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Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)	ASTM	F3366-19		P				
Guide to Developing and Sustaining Preventive Maintenance Programmes	UK MAA	JAP(D)100C-22		F	F			
Operator/Manufacturer Scheduled Maintenance Development	A4A	MSG-3		F	F			
International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	ASD	S4000P		F	F			
Small Unmanned Aircraft Systems	FAA	AC107-2	F					
Assurance								
Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	ASTM	F2483 - 18		F				
Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	ASTM	F2909-19		F				
Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)	ASTM	F3366-19		P				
Guide to Developing and Sustaining Preventive Maintenance Programmes	UK MAA	JAP(D)100C-22		F	F			
Operator/Manufacturer Scheduled Maintenance Development	A4A	MSG-3		F	F			
International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	ASD	S4000P		F	F			
UAS Maintenance Technician Qualification	ASTM	WK60659						(F)
Training for UAS personnel	ISO	23665					F	
Unmanned Aircraft System (UAS) Maintenance Standard	NCATT	NCATT						F

3.8.3 Integrity Coverage Detail

Table 143

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	ASTM	F2483 - 18		F		The standard is not specific for UAS

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The standard provides guidelines for the qualifications to accomplish the various levels of maintenance on US-certified experimental and special light sport aircraft. In addition, it provides the content and structure of maintenance manuals for aircraft and their components that are operated as light sport aircraft.
It addresses maintenance instructions, maintenance staff and maintenance program. It can be used to cover OSO#3, although it is not specific for UAS.

Table 144

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS)	ASTM	F2909-19		F		It is only applicable for UAS with MTOM less than 25 kg.
The standard provides guidelines for the maintenance and continued airworthiness of sUAS. It provides the content and structure of maintenance manuals for sUAS It addresses maintenance instructions and maintenance staff. It can be used to cover OSO#3, adequate for the lower SAILs						

Table 145

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)	ASTM	F3366-19		P		It is only applicable for UAS with MTOM less than 25 kg. It only covers the development of a Maintenance Manual.
The standard provides high level guidelines for the development of a maintenance manual. No specific maintenance practices or instructions are provided.						

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guide to Developing and Sustaining Preventive Maintenance Programmes	UK MAA	JAP(D)100C-22		F	F	

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This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Operator/Manufacturer Scheduled Maintenance Development	A4A	MSG-3		F	F	
This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)						

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	ASD	S4000P		F	F	
This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)						

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Small Unmanned Aircraft Systems	FAA	AC107-2	F			
No standard is required for Low robustness, Appendix C of the AC contains maintenance and inspection best practices for small UAS. It is applicable for UAS with MTOM less than 25kg						

3.8.4 Assurance Coverage Detail

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Table 146

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft	ASTM	F2483 - 18		F					The standard is not specific for UAS
The standard provides guidelines for the qualifications to accomplish the various levels of maintenance on US-certified experimental and special light sport aircraft. In addition, it provides the content and structure of maintenance manuals for aircraft and their components that are operated as light sport aircraft. It addresses maintenance instructions, maintenance staff and maintenance program. It can be used to cover OSO#3, although it is not specific for UAS.									

Table 147

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Specification for Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS)	ASTM	F2909-19		F					It is only applicable for UAS with MTOM less than 25 kg.
The standard provides guidelines for the maintenance and continued airworthiness of sUAS. It provides the content and structure of maintenance manuals for sUAS It addresses maintenance instructions and maintenance staff. It can be used to cover OSO#3, adequate for the lower SAILs									

Table 148

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)	ASTM	F3366-19		P					It is only applicable for UAS with MTOM less than 25 kg. It only covers the development of a Maintenance Manual.

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The standard provides high level guidelines for the development of a maintenance manual. No specific maintenance practices or instructions are provided.

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Guide to Developing and Sustaining Preventive Maintenance Programmes	UK MAA	JAP(D)100C-22		F	F				
This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)									

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Operator/Manufacturer Scheduled Maintenance Development	A4A	MSG-3		F	F				
This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)									

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
International Procedure Specification for Developing and Continuously Improving Preventive Maintenance	ASD	S4000P		F	F				
This document provides full coverage to all levels of robustness. It is not limited to maximum take-off weight or to aircraft type (fixed \ rotary wing)									

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
UAS Maintenance Technician Qualification	ASTM	WK60659						(F)	

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The assessment was based on general data, because the draft was not available. The document addresses training of maintenance staff and therefore it is expected to cover very well the training syllabus and training program

Table 149

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Training for UAS personnel	ISO	23665					F		The standard does not represent a guidance for the development of a maintenance program.

This standard deals with training of personnel involved in UAS operations. Training items include maintenance activities, but the standard does not represent a guidance for the development of a maintenance program.

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Unmanned Aircraft System (UAS) Maintenance Standard	NCATT	N/A						F	

The standard can be used by aerospace industry education and training entities to develop lesson plans as part of a complete education and training program focused on UAS maintenance.

3.8.5 Gaps

The standards that are currently available are covering sufficiently the requirements of OSO #3 for all Robustness levels which are required for all SAIL level of operation.

3.8.6 Conclusions and Recommendations

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Table 150 Recommended Standards – Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion 1	Low	Full	NO STANDARD REQUIRED	The following standards can be used as advisory material: ASTM F2909-19, ASTM 2483-18, ASTM F3366-19 and AC 107-2 Chapter 7.		
	Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		11	
		Full	ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft		10	
		Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		9	
		Partial	ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM less than 25kg Covers only development of a Maintenance Manual	4	
	High	Full	S4000P - International Procedure Specification for Developing and Continuously Improving Preventive Maintenance		13	
			JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		11	

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			MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		9	

Table 151 Recommended Standards – Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion 1	Low	Full	NO STANDARD REQUIRED	The following standards can be used as advisory material: ASTM F2909-19, ASTM 2483-18, ASTM F3366-19 and AC 107-2 Chapter 7.		
	Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		11	
		Full	ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft		10	
		Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		9	
		Partial	ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM less than 25kg Covers only development of a Maintenance Manual	4	

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	High	Full	S4000P - International Procedure Specification for Developing and Continuously Improving Preventive Maintenance		13	
			JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		11	
			MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		9	
Criterion 2 (Training)	Low	N/A	NO STANDARD REQUIRED			
	Medium	N/A	NO STANDARD REQUIRED	ISO 23665 could be used as guidance	10	
	High	Full	NCATT – Unmanned Aircraft System (UAS) Maintenance Standard		12	
			WK60659 - UAS Maintenance Technician Qualification	Assessment done only on the outline of the document.	6	

3.9 *OSO 05* – UAS is designed considering systems safety and reliability

3.9.1 Requirement Description

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Table 152 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The equipment, systems, and installations are designed to minimize hazards in the event of a probable malfunction or failure of the UAS.
	Medium	Same as Low. In addition, the strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard is available.
	High	Same as Medium. In addition: • Major Failure Conditions are not more frequent than Remote; • Hazardous Failure Conditions are not more frequent than Extremely Remote; • Catastrophic Failure Conditions are not more frequent than Extremely Improbable; • Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) may cause or contribute to hazardous or catastrophic failure conditions are developed to an industry standard or a methodology considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority.

Table 153 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	A Functional Hazard Assessment and a design and installation appraisal that shows hazards are minimized are available.
	Medium	Same as Low. In addition: • Safety analyses are conducted in line with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • A strategy for detection of single failures of concern includes pre-flight checks.
	High	Same as Medium. In addition, safety analyses and development assurance activities are validated by EASA, according to Article 40 of Regulation (EU) 2019/945.

3.9.2 Summary

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Table 154 OSO 5 Integrity: Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity					
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F	P	
Generic Functional Hazard Assessment (FHA) for UAS/RPAS	EUROCAE	ED-279	F	P	P
Guidelines for Development of Civil Aircraft and Systems	EUROCAE	ED-79			P
Software Considerations in Airborne Systems and Equipment Certification	EUROCAE /RTCA	ED-12/DO-178			P
Design Assurance Guidance for Airborne Electronic Hardware	EUROCAE /RTCA	ED-80/ DO-254			P
Assurance					
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F	P	
Generic Functional Hazard Assessment (FHA) for UAS/RPAS	EUROCAE	ED-279	F	P	P
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3309		P	P
Practice for Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3230		P	P
Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761A		P	P

3.9.3 Integrity Coverage Detail

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Table 155

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F	P		Does not cover a strategy for detection, alerting and management of any malfunction or failure.

Notes:

1. This document summarizes the proposed procedure that a UAS operator or manufacturer has to perform in order to develop the functional hazard assessment and the safety analysis required to fulfil OSO#5 requirements at Low and Medium Robustness.

Table 156

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Generic Functional Hazard Assessment (FHA) for UAS/RPAS	EUROCAE	ED-279	F	P	P	Detection means, mitigations strategies, and failures that occur during maintenance or pre-flight operations are not considered.

Notes:

1. Published
2. This document provides UAS systems developers a framework to support designers when performing the FHA process.

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

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Guidelines for Development of Civil Aircraft and Systems	EUROCAE	ED-79A			P	Set of considerations which should be used together with other standards in order to fulfil safety requirements.

Notes:
1. Published
2. The standard discusses validation of requirements and verification of the design implementation for certification and product assurance.

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Software Considerations in Airborne Systems and Equipment Certification	EUROCAE/RTCA	ED-12/DO-178			P	The standard only addresses Software.

Notes:
1. Published
2. The standard discusses those aspects of certification that pertain to the production of software for airborne systems and equipment used on aircraft, engines, propellers and, by region, auxiliary power units.

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Design Assurance Guidance for Airborne Electronic Hardware	EUROCAE/RTCA	ED-80/DO-254			P	Set of considerations for hardware design which should be used together with other standards in order to fulfil safety requirements.

Notes:
1. Published
2. The standard provides guidance for design assurance of airborne electronic hardware.

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3.9.4 Assurance Coverage Detail

Table 157

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F	P		Does not cover a strategy for detection of single failures of concern includes pre-flight checks that is required for Medium Robustness.

Notes:

1. This document summarizes the proposed procedure that a UAS operator or manufacturer has to perform in order to develop the functional hazard assessment and the safety analysis required to fulfil OSO#5 requirements at Low and Medium Robustness.

Table 158

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Generic Functional Hazard Assessment (FHA) for UAS/RPAS	EUROCAE	ED-279	F	P	P	Detection means, mitigations strategies, and failures that occur during maintenance or pre-flight operations are not considered.

Notes:

1. Published
2. This document provides UAS systems developers a framework to support designers when performing the FHA process.

Table 159

Standard Title	SDO	Doc. Reference	Criterion 1	Gaps

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			L	M	H	
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3309		P	P	This standard is not specific for UAS and should be adapted.

Notes:
1. Published
2. The standard covers methods for conducting a simplified safety assessment of aircraft systems and equipment

Table 160

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Practice for Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3230		P	P	This standard is not specific for UAS and should be adapted.

Notes:
1. Published
2. The standard covers methods for conducting a simplified safety assessment of aircraft systems and equipment

Table 161

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761A		P	P	This standard is not specific for UAS and should be adapted.

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Notes:
1. Published
2. The standard describes Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment and can be used to fulfil OSO #5 at High Level of Robustness.

3.9.5 Gaps

The standards that are currently available are covering sufficiently the requirements of OSO #5 for the Medium Level of Integrity. The need for "strategy for detection of single failures of concern includes pre-flight checks" required at Medium level is not fully covered yet but the new revision of EUROCAE ED-280 is expected to include this aspect as well. For a higher SAIL, the available standards for Software and Airborne Electronic Hardware (AEH) Development Assurance are not tailored for UAS and might be difficult to use for COTS products. However, this gap is expected to be solved by the work that is being carried out by EUROCAE WG-117. For High Level of assurance a tailored version of SAE and ASTM standards would be needed as they are specific for manned aviation.

3.9.6 Conclusions and Recommendations

Table 162 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		12	
			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		13	
	Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	Not covering the part related to	9	No gap as the missing aspect will be covered in the next release

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			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS	"detection of single failures…"	9	
	High	Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS	Each of the proposed standards has a partial coverage, but their combination is expected to provide a full coverage, even though some adaptations might be required to tailor the standard to UAS.	9	
			EUROCAE ED-79A Guidelines for Development of Civil Aircraft and Systems		8	Too demanding for COTS UAS. Gap will be covered by EUROCAE WG-117.
			EUROCAE /RTCA ED-12/DO-178 Software Considerations in Airborne Systems and Equipment Certification		8	
			EUROCAE /RTCA ED-80/DO-254 Design Assurance Guidance for Airborne Electronic Hardware		8	

Table 163 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		12	
			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		13	

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	Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	Not covering the part related to "detection of single failures…"	9	No gap as the missing aspect will be covered
		Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	
		Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft	These standards are intended for Manned Aviation, so adaptation would be needed.	4	
		Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft		6	
		Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment		4	
	High	Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft		4	
		Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft		6	
		Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment		6	

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		Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	

3.10 *OSO 06* – C3 link characteristics appropriate for the operation

3.10.1 Requirement Description

Table 164 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	• The applicant determines that performance, RF spectrum usage and environmental conditions for C3 links are adequate to safely conduct the intended operation. • The UAS remote pilot has the means to continuously monitor the C3 performance and ensures the performance continues to meet the operational requirements.
	Medium	Same as Low.
	High	Same as Low. In addition, the use of licensed frequency bands for C2 Link is required.

Table 165 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The applicant declares that the required level of integrity has been achieved.
	Medium	Demonstration of the C3 link performance is in accordance with standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority.
	High	Same as Medium. In addition, evidence is validated by a competent third party.

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3.10.2 Summary

Table 166 OSO 6 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Technology	Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
				L	M	H
Integrity						
General	Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	ASTM	F3002 – 14	P	P	
	Guidance on Spectrum Access, Use and Management for UAS	EUROCAE	ED-266	P	P	P
	Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial)	RTCA	DO-362	P	P	P
	Interoperable Command and Control Datalink for Unmanned Systems	NATO NNAG/JCGUAS	STANAG 4660	(P)	(P)	(P)
	Minimum Aviation Systems Performance Standard for Remote Pilot Stations supporting IFR operations into non-segregated airspace	EUROCAE	ED-272	(P)	(P)	(P)
	Requirements for ensuring the safety and quality of the design and manufacture of UAS	ISO	21384-2	(P)	(P)	(P)
	Dedicated Short Range Communications (DSRC) Message Set Dictionary	SAE	J2735_201603	(P)	(P)	(P)
	Interoperable Command and Control Data Link for Unmanned Systems (IC2DL) – Operational Physical Layer / Signal in Space Description	NATO	AEP-77	(P)	(P)	(P)
	Standards for Aerial Communications and Networks	IEEE	P1920.1	(P)	(P)	(P)

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	Standards for Vehicle to Vehicle Communications for UAS (Unmanned Aircraft Systems)	IEEE	P1920.2	(P)	(P)	(P)
	Unmanned Aircraft Systems — Product requirements for UAS in the open category	ASD-STAN	prEN 4709-001-2019	(P)	(P)	(P)
	RPAS C2 link Required Communication Performance (C2 link RCP) concept	JARUS	N.A.	(P)	(P)	(P)
WIFI	WIFI technology (2.4 GHz + 5 GHz Band)	IEEE	802.11 + 802.11a	P	P	
Bluetooth	Bluetooth technology	IEEE	802.15.1	P	P	
WRAN	Wireless regional area network (WRAN)	IEEE	802.22	P	P	
LTE	Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles	3GPP	TR 36.777	P	P	
Satellite	Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)	EUROCAE	ED-265	P	P	P
	IP over Satellite (IPoS)	TIA	TIA-1008	(P)	(P)	(P)
Assurance						
	New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control	ASTM	WK58930		(P)	(P)

3.10.3 Integrity Coverage Detail

Table 167

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	ASTM	F3002 – 14	P	P		

Notes:

1. Applicable to low risk operations.

Table 168

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
WIFI technology (2.4 GHz + 5 GHz Band)	IEEE	802.11 + 802.11a	P	P		

Notes:

1. Only applicable to WIFI technology.

Table 169

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Bluetooth technology	IEEE	802.15.1	P	P		

Notes:

1. Only applicable to Bluetooth technology.

Table 170

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Wireless regional area network (WRAN)	IEEE	802.22	P	P		

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Notes:

1. Only applicable to WRAN technology.

Table 171

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles	3GPP	TR 36.777	P	P		

Notes:

1. Only applicable to LTE technology.

Table 172

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidance on Spectrum Access, Use and Management for UAS	EUROCAE	ED-266	P	P	P	

Notes:

1. Applicable to communication with Unmanned Airborne Vehicles (UAVs), the airborne part of Unmanned Aircraft Systems (UAS), and to Remotely Piloted Aircraft (RPA), the airborne part of Remotely Piloted Aircraft Systems (RPAS).

Table 173

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial)	RTCA	DO-362	P	P	P	This standard is applicable only for terrestrial C2 Link.

Notes:
1. The use of this standard might be too demanding for the Low and Medium levels of Robustness.

Table 174

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)	EUROCAE	ED-265	P	P	P	

Notes:
1. Ongoing (draft available)
2. The Standard is about defining minimum operational performance standard for the satellite Line of Sight Command and Control Data Link.
3. The use of this standard might be too demanding for the Low and Medium levels of Robustness.

Table 175

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Interoperable Command and Control Datalink for Unmanned Systems	NATO NNAG/JCGUAS	STANAG 4660	P	P	P	The standard covers detailed performance requirements as well as continuous measurement of the circuit latency.

Notes:
1. Published
2. The Standard covers standard Line-Of-Sight command and control data link
3. The use of this standard might be too demanding for the Low and Medium levels of Robustness.

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Table 176

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Minimum Aviation Systems Performance Standard for Remote Pilot Stations supporting IFR operations into non-segregated airspace	EUROCAE	ED-272	P	P	P	This standard only covers the requirements for C2 link at RPS level.

Notes:

1. The Standard defines Minimum Aviation System Performance Standard at system level for the Remote Pilot Station interface to Air Traffic Control
2. The use of this standard might be too demanding for the Low and Medium levels of Robustness.

Table 177

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Requirements for ensuring the safety and quality of the design and manufacture of UAS	ISO	21384-2	(P)	(P)	(P)	This is a high level standard that would need to be complemented by other more specific ones to demonstrate compliance.

Notes:

1. Ongoing
2. The standard cannot be downloaded but the subject can be identified
3. The Standard defines requirements for ensuring the quality and safety of the design and manufacture UAS

Table 178

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Dedicated Short Range Communications (DSRC) Message Set Dictionary	SAE DSRC (Dedicated Short Range Communication) Tech Committee	J2735_201603	P	P	P	Must be used in connection with other standards which help define the requirements performance level for the use of the messages defined in this standard.

Notes:

1. Published
2. The standard specifies a message set, and its data frames and data elements, specifically for use by applications intended to utilize the 5.9 GHz Dedicated Short Range Communications for Wireless Access in Vehicular Environments (DSRC/WAVE, referenced in this document simply as “DSRC”) communications systems

Table 179

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Interoperable Command and Control Data Link for Unmanned Systems (IC2DL) – Operational Physical Layer / Signal in Space Description	NATO	AEP-77	P	P	P	The standard refers to performance requirements and measurement of latency and processing time between nodes.

Notes:

1. Published
2. The standard defines a standard Line Of Sight (LOS) Interoperable Command and Control Data Link (IC2DL) for Unmanned Systems

Table 180

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION’S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Standards for Aerial Communications and Networks	IEEE Standards Association	P1920.1	P	P	P	The standard is still in planning phase. It cannot be judged since it is not yet available. Potentially partially covers some of the requirements of OSO#6 (C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation.) but it cannot be properly judged

Notes:

1. Draft
2. The standard cannot be downloaded but the subject can be identified
3. The Standard defines air-to-air communications for self-organized ad hoc aerial networks

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standards for Vehicle to Vehicle Communications for UAS (Unmanned Aircraft Systems)	IEEE Standards Association	P1920.2	P	P	P	The standard is still in planning phase. It cannot be judged since it is not yet available. Potentially partially covers some of the requirements of OSO#6 (C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation.) but it cannot be properly judged.

Notes:

1. Planned
2. The standard cannot be downloaded but the subject can be identified
3. The Standard defines the protocol for exchanging information between the vehicles

Table 181

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Unmanned Aircraft Systems — Product requirements for UAS in the open category	ASD-STAN	prEN 4709-001-2019	P	P	P	The standards refers to how to test the link performance and how to proceed in case of loss of data link. However, it is specifically intended for UAS in the Open category. Therefore its applicability must be judged depending on the type of operation.

Notes:
1. Ongoing (draft available)
2. The Standard defines means of compliance with product requirements for all UAS authorized to operate in the 'open' category (class C0, C1, C2, C3 and C4 UAS).

Table 182

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
IP over Satellite (IPoS)	TIA	TIA-1008	P	P	P	The standard needs to be downloaded and studied. Potentially partially covers some of the requirements of OSO#6 (C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation.) but it cannot be properly judged.

Notes:
1. Published
2. The standard cannot be downloaded but the subject can be identified
3. The standard contains the procedures used by remote terminals and the hub for delivery of traditional Internet Protocol (IP) services in a star satellite access network

Table 183

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

RPAS C2 link Required Communication Performance (C2 link RCP) concept	JARUS		P	P	P	This document defines that the RPAS C2 link must meet the performance or safety requirements of the operational airspace. Additionally, monitoring must be in place to determine if the C2 communication service provider continues to meet the C2 link RCP type. However, it only provides guidance.

Notes:

1. Published
2. The standard cover the requirements for the C2 link in RPAS

3.10.1 Assurance Coverage Detail

Table 184

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control	ASTM E54 Homeland Security Applications	WK58930	P	P	P	The standard is still ongoing. It cannot be judged since it is not yet available. The test can be used to partially show that the latency of communications is minimized.

Notes:

1. Ongoing
2. The Standard defines a new test method to specify the apparatuses, procedures, and performance metrics necessary to quantitatively evaluate the latency of video, audio, and control sub-systems as viewed through a control station

3.10.2 Gaps

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Table 185 Gap Summary - OSO 06

Gap	Gap Description	Total Weighted Score	Conclusion Recommendation
1	All identified technical standards cover Command and Control, but there is no standard to develop communication functionalities where needed/relevant.	-4	It is recommended to develop a standard to harmonize the development of the communication link.

3.10.2.1 Details

Table 186

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	All identified technical standards cover Command and Control, but there is no standard to develop communication functionalities where needed/relevant	Safety (3)	High	The lack of standards to support operators in demonstrating that the Communication Link is adequate for the scope can have a negative impact on safety due to the absence of a common reference.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standards to standards to support operators in demonstrating that the Communication Link is adequate may lead to additional costs for the demonstration of compliance to the OSO #6 requirements.	0	0
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Negative	The EU industry competitiveness can be negatively impacted due to the lack of common requirements/procedures for UAS Communication.	-1	-1
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-4**

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3.10.3 Conclusions and Recommendations

Most existing standards specifically aimed at Command and Control link are deemed too demanding for low risk operations. Hence, the assessment covers lower risk operations by addressing standards covering WIFI, Bluetooth and LTE technologies for their simplicity. For SAILs V and VI, standards EUROCAE ED-266 and RTCA DO-362 / EUROCAE ED-265 are recommended. Additionally, EUROCAE WG-105 SG-2 is currently working on a standard for this OSO covering communications by 4G LTE for UAS. This work will be monitored.

Finally, a gap was identified in the lack of standards/guidelines for the Communication section of the C3 Link, specifically with ATS. However, it is also considered that for specific operations of very low risk, the latter may not be necessary.

Table 187 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARDS REQUIRED – The standards applicable to Medium Robustness may also be applicable for a Low level of Robustness.			
	Medium	Partial	ASTM F3002 – 14 - Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	Only applicable to UAS with MTOM below 25Kg.	6	
		Partial	IEEE 802.11, IEEE 802.11a – WIFI technology (2.4 GHz + 5 GHz Band)	Only covers WIFI	6	
		Partial	IEEE 802.15.1 – Bluetooth technology	Only covers Bluetooth	6	
		Partial	IEEE 802.22 - Wireless regional area network (WRAN)	Only covers WRAN	6	

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		Partial	3GPP - TR 36.777 Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles	Only covers LTE	6	
		Partial	EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS	Applicable to communication with Unmanned Airborne Vehicles (UAVs), the airborne part of Unmanned Aircraft Systems (UAS), and to Remotely Piloted Aircraft (RPA), the airborne part of Remotely Piloted Aircraft Systems (RPAS).	2	
	High	Partial	EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS	Applicable to communication with Unmanned Airborne Vehicles (UAVs), the airborne part of Unmanned Aircraft Systems (UAS), and to Remotely Piloted Aircraft (RPA), the airborne part of Remotely Piloted Aircraft Systems (RPAS).	4	
		Partial	RTCA DO-362 - Command and Control (C2) Data Link Minimum Operational Performance Standard (MOPS) (Terrestrial)	Only covers terrestrial C2 link.	4	
		Partial	EUROCAE ED-265 - Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)	Only covers satellite C2 link. The standard is still in the Open Consultation phase.	2	

Table 188 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
	Low	N.A.	NO STANDARD REQUIRED			

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Criterion #1	Medium	Partial	ASTM WK58930: New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control	The document is a draft		
	High	Partial	ASTM WK58930: New Test Method for Evaluating Aerial Response Robot Sensing: Latency of Video, Audio, and Control	The document is a draft		

3.11 *OSO 07* – Inspection of the UAS […] to ensure consistency to the ConOps

3.11.1 Requirement Description

Table 189 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The remote crew ensures the UAS is in a condition for safe operation and conforms to the approved concept of operations.
	Medium	
	High	

Table 190 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	Product inspection is documented and accounts for the manufacturer's recommendations if available.
	Medium	Same as Low. In addition, the product inspection is documented using checklists.
	High	Same as Medium. In addition, the product inspection is validated by a competent third party.
Criterion #2	Low	The remote crew's is trained to perform the product inspection, and that training is self-declared (with evidence available).
	Medium	• A training syllabus including a product inspection procedure is available. • The operator provides competency-based, theoretical and practical training.
	High	A competent third party validates the training syllabus and verifies the remote crew competencies.

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3.11.2 Summary

Table 191 OSO 7 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	(P)	(P)	(P)
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707	(P)	(P)	(P)
Standard for Small Unmanned Aircraft Systems (sUAS) Used for Public	NFPA	NFPA 2400	(P)	(P)	(P)
Unmanned aircraft systems – Part 3: Operational procedures	ISO	21384-3	P	P	P
Training for personnel involved in UAS operations	ISO	23665	P	P	P
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18	(P)	(P)	(P)
Department of Defense Standard Practice System Safety	DoD	MIL-STD-882E	(P)	(P)	(P)

3.11.3 Coverage Detail

Table 192

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	(P)	(P)	(P)	The standard is still under development. It cannot be assessed since it is not yet available. Probably it partially covers some of the requirements of OSO #7

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This standard defines the requirements for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS). The standard addresses the requirements and/or best practices for documentation and organization of a professional operator (i.e., for compensation and hire).

Table 193

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707	(P)	(P)	(P)	Does not cover the integrity requirements. Does not cover assurance requirements apart from the fact that preflight inspection must be included as a training topic.
This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) for use by operators, manufacturers, and regulators. The identification of training topics is based initially on Practical Test Standard (PTS) topics for manned aircraft pilots. The topics identified could be used for the construction of a PTS for UAS commercial pilot operations and a PTS for a UAS pilot instrument rating. The UAS commercial pilot rating would contain restrictions on the types of operations that can be flown that are be dependent on the type of UAS used. Preflight inspection is included as a training topic.						

Table 194

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard for Small Unmanned Aircraft Systems (sUAS) used for Public Safety Operations	NFPA	NFPA 2400	(P)	(P)	(P)	The abstract is insufficient to precisely assess coverage. Potentially, it partially covers the requirements of OSO#7

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NFPA 2400 provides a roadmap for employing small drones for incident response operations, including:

- Primary concerns and procedures for integrating sUAS into a public safety program
- Considerations and organizational deployment requirements for program development, assessment, general operations, and multiple aircraft operations
- Professional qualifications for public safety personnel, and minimum job performance requirements that can be evaluated and tested for remote pilots in command
- Pre-flight checklists, risk assessment procedures, and considerations of mission objectives
- Requirements for maintenance of sUAS covering core procedural elements such as cleaning, decontamination, and record keeping

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Table 195

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems - Part 3: Operational procedures	ISO	21384-3	P	P	P	Does not cover training part of assurance requirements for Low, Medium and High levels of robustness. Missing in assurance requirements: • For Low level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. • For Medium level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. In addition, the product inspection is documented using checklists. • For High level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. In addition, the product inspection is documented using checklists. A competent third party validates the training syllabus and verifies the remote crew competencies.
This standard gives the requirements for safe commercial UA operations and applies to all types, categories, classes, sizes, and modes of operation of UA. A section is specifically dedicated to pre-flight inspections, therefore the standard covers the integrity requirements. This standard partly covers the procedure part of the assurance requirements; it contains a detailed checklist.						

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Table 196

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Training for personnel involved in UAS operations	ISO	23665	P	P	P	Does not cover the integrity requirements for Low, Medium and High levels of robustness. Missing in assurance requirements: • For Low level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. • For Medium level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. The product inspection is documented using checklists. • For High level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. The product inspection is documented using checklists. A competent third party validates the training syllabus and verifies the remote crew competencies.
The standard provides training recommendations for UAS personnel, including practical training on pre-flight inspection skills. This standard covers the training part of the assurance requirements.						

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Table 197

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18	(P)	(P)	(P)	Does not cover the integrity requirements. Does not cover assurance requirements apart from that the standard could help identify the structure of the training manual.
1.1 This specification defines the requirements for training and the development of training manuals for the unmanned aircraft systems (UAS) operator. 1.2 The specification addresses the requirements or best practices, or both, for documentation and organization of a professional operator (that is, for compensation and hire) for the purposes of internal training programs and for programs offered to the general public. 1.3 This specification supports professional entities that will receive operator certification by a CAA, and provide standards of practice for self- or third-party audit of operators of UAS. 1.4 The standard case study used to develop this specification focused on operators of light UAS (below 1320 lb/600 kg as defined by EASA), but the specification may be applied to larger aircraft for using other methods of classification (that is, risk based classes and pilot privileges classes). This standard could help identify the structure of the training manual.						

Table 198

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Department of Defense Standard Practice System Safety	DoD Department of Defense	MIL-STD-882E	(P)	(P)	(P)	Does not cover the integrity requirements. Does not cover assurance requirements apart from that the standard could help identify product inspection items.

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Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
This system safety standard practice identifies the Department of Defense (DoD) Systems Engineering (SE) approach to eliminating hazards, where possible, and minimizing risks where those hazards cannot be eliminated. DoD Instruction (DoDI) 5000.02 defines the risk acceptance authorities. This Standard covers hazards as they apply to systems / products / equipment / infrastructure (including both hardware and software) throughout design, development, test, production, use, and disposal. When this Standard is required in a solicitation or contract but no specific task is identified, only Sections 3 and 4 are mandatory. The definitions in 3.2 and all of Section 4 delineate the minimum mandatory definitions and requirements for an acceptable system safety effort for any DoD system. This standard could help identify product inspection items.						

3.11.4 Gaps

Table 199 Gap Summary - OSO 7

Gap	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Absence of standards covering: Product inspection is documented and accounts for the manufacturer's recommendations if available	10	No need to develop a standard for this gap.
2	Absence of standards covering: A competent third party validates the training syllabus and verifies the remote crew competencies.	-1	There is need to develop a suitable standard for the competence of a third party.

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3.11.4.1 Details

Table 200

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Absence of standards covering" Product inspection is documented and **accounts for the manufacturer's recommendations if available**.	Safety (3)	Very low	The risk that inspection items are overlooked in the manufacturer recommendations because of the lack of a standard that includes a comprehensive list of inspection items, is judged to be very low. Manufacturers know best what to include in their product inspection recommendations	2	6
		Cost of compliance to the requirement with a lack standard (2)	Low	The cost for the manufacturer to develop a set of product inspection recommendations that includes all applicable items is judged to be low. Manufacturers know best what to include in their product inspection recommendations.	1	2
		Environmental Impact (1)	No impact	No impact on the basis that manufacturers include all relevant inspection items.	0	0
		Impact on EU Industry competitiveness (1)	Very positive	Manufacturers know best what to include in their product inspection recommendations.	2	2
Total Weighted Score						**10**

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Absence of standards covering: A competent third party validates the training syllabus and verifies the	Safety (3)	Very low	Without a specification of when a third party is considered competent, there is a risk that the third party overlooks missing elements in the training syllabus or insufficient remote crew competences. However as the training syllabus itself is based on a standard the chance of missing items in the training syllabus is very low. The chance of insufficient remote crew competences is	0	0

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	remote crew competencies.			also very low as the operator provides competency-based, theoretical and practical training.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	Without a specification of when a third party is considered competent, there is a risk for the operator that the third party works in an inefficient manner. The risk is judged to be average hence the rating “medium”.	0	0
		Environmental Impact (1)	No impact	No impact on the basis that manufacturers include all relevant inspection items.	0	0
		Impact on EU Industry competitiveness (1)	Negative	Without a specification of when a third party is considered competent, there is a risk for the operator that the third party works in an inefficient manner, as well as a risk that the approval of the third party by regulators takes time.	-1	-1
Total Weighted Score						**-1**

3.11.5 Conclusions and Recommendations

ISO standards are available that cover the integrity requirements and the training part of the assurance requirements. They partly cover the procedure part of the assurance requirements.
The assurance requirement that product inspection documentation **accounts for the manufacturer’s recommendations if available** is not covered.
The gap assessment shows that this gap is not significant: the risk that inspection items are overlooked in the manufacturer recommendations because of the lack of a standard that includes a comprehensive list of inspection items, was judged to be very low as manufacturers know best what to include in their product inspection recommendations. Consequently, there is no recommendation to develop a standard for this.

The assurance requirement that a **competent third party validates the training syllabus and verifies the remote crew competencies** is not covered.
The gap assessment shows that there is need to develop a suitable standard for the competence of a third party.

The following ASTM standard has not yet been assessed because of non-availability to the consortium or being still under development. This could potentially form an alternative to the recommended ISO standards:

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- ASTM WK62744 - New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)

Table 201 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Gaps	Score
Criterion #1	Low	Full	ISO 21384-3: Operational Procedures	It only provides high level guidance	none	12
	Medium	Full	ISO 21384-3: Operational Procedures	It only provides high level guidance	none	12
	High	Full	ISO 21384-3: Operational Procedures	It only provides high level guidance	none	12

Table 202 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Gaps	Score
Criterion #1	Low	Partial	ISO 23665 – Training for personnel involved in UAS operations	It only provides high level guidance. This document is pending publication	Missing in assurance requirements: Product inspection is documented and accounts for the manufacturer's recommendations if available.	0
	Medium	Partial	ISO 21384-3: Operational Procedures	It only provides high level guidance	Missing in assurance requirements: Product inspection is documented and accounts for the manufacturer's recommendations if available.	6

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			ISO 23665 – Training for personnel involved in UAS operations	It only provides high level guidance	Missing in assurance requirements: • Product inspection is documented and accounts for the manufacturer's recommendations if available. • The product inspection is documented using checklists.	2
	High	Partial	ISO 21384-3: Operational Procedures	It only provides high level guidance	Missing in assurance requirements: • Product inspection is documented and accounts for the manufacturer's recommendations if available. • A competent third party validates the training syllabus and verifies the remote crew competencies.	4
			ISO 23665 – Training for personnel involved in UAS operations	It only provides high level guidance	Missing in assurance requirements: • Product inspection is documented and accounts for the manufacturer's recommendations if available. • The product inspection is documented using checklists. A competent third party validates the training syllabus and verifies the remote crew competencies.	4

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3.12 *OSO 08, 11, 14, 21* Operational Procedures

- OSO #8 - Operational procedures are defined, validated and adhered to address technical issues with the UAS
- OSO #11 - Procedures are in-place to handle the deterioration of external systems supporting UAS operation
- OSO #14 - Operational procedures are defined, validated and adhered to (to address Human Errors)
- OSO #21 - Operational procedures are defined, validated and adhered to (to address Adverse Operating Conditions)

3.12.1 Requirement Description

Table 203 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Procedure definition)	Low/Medium/High	Operational procedures appropriate for the proposed operation are defined and as a minimum cover the following elements: • Flight planning, • Pre and post-flight inspections, • Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation), • Procedures to cope with unintended adverse operating conditions (e.g. when ice is encountered during an operation not approved for icing conditions) • Normal procedures, • Contingency procedures (to cope with abnormal situations), • Emergency procedures (to cope with emergency situations), and • Occurrence reporting procedures. Normal, Contingency and Emergency procedures are compiled in an Operation Manual. The limitations of the external systems supporting UAS operation are defined in an Operation Manual.
Criterion #2 (Procedure complexity)	Low	Operational procedures are complex and may potentially jeopardize the crew ability to respond by raising the remote crew's workload and/or the interactions with other entities (e.g. ATM…).

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	Medium	Contingency/emergency procedures require manual control by the remote pilot when the UAS is usually automatically controlled.
	High	Operational procedures are simple.
Criterion #3 (Consideration of Potential Human Error)	Low	At a minimum, operational procedures provide: • a clear distribution and assignment of tasks an internal checklist to ensure staff are adequately performing assigned tasks.
	Medium	Operational procedures take human error into consideration.
	High	Same as medium. In addition, the Remote Crew receives CRM (Crew Resource Management) training

Table 204 Assurance Requirements' Description

Criterion	Robustness	Description
Criteria	Low	• Operational procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. • The adequacy of the operational procedures is declared, except for emergency procedures, which are tested.
	Medium	• Operational procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • Adequacy of the contingency and emergency procedures is proven through: ○ dedicated flight tests; or ○ simulation, provided the simulation is proven valid for the intended purpose with positive results.
	High	Same as medium. In addition: • Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative. • The procedures, checklists, flight tests and simulations are validated by a competent third party.

3.12.2 Summary

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Table 205 OSO 08, 11, 14, 21 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness Criterion 1	Robustness Criterion 2			Robustness Criterion 3		
			L/M/H	L	M	H	L	M	H
Integrity									
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P					P	P
Minimum Aviation System Performance Standard (End-to-end Requirements at system level) for Automatic Take-Off and Landing - MASPS	EUROCAE	N.A.	(P)						
Minimum Aviation System Performance Standard (End-to-end Requirements at system level) for Automatic Taxiing	EUROCAE	N.A.	(P)						
Minimum Aviation System Performance Standard (End-to-end Requirements at system level) for automation and Emergency Recovery - MASPS	EUROCAE	N.A.	(P)						
Assurance									
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P P						

Table 206 OSO 08, 11, 14, 21 Documents not available or under development

Standard Title	SDO	Doc. Reference	Notes
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	Draft under development – document not available
Standard Practice for Independent Audit Program for Unmanned Aircraft Operators	ASTM	F3364-19	Document not available – On-going

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UAS Operator Compliance Audits	ASTM	WK62731	Document not available – On-going
Flight beyond visual line of sight	SAE	N.A.	Doc Planned
Night Operations	SAE	N.A.	Doc Planned
Aerial photography	SAE	N.A.	Doc Planned
Power line inspections	SAE	N.A.	Doc Planned
Precision agriculture	SAE	N.A.	Doc Planned
Bridge inspection	SAE	N.A.	Doc Planned
Train right-of-way's	SAE	N.A.	Doc Planned
Flare stack inspections	SAE	N.A.	Doc Planned
Guide to the Preparation of Operational Concept Documents	AIAA	AIAA G-043B-2018	Document not available
Practice for Visual Signals Between Persons on the Ground and in Aircraft During Ground Emergencies	ASTM	F1591	Document not available
Practice for Communications Procedures—Phonetics	ASTM	F1583	Document not available
Standard Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)	ASTM	F2908-18	Document not available

3.12.3 Integrity Coverage Detail

Table 207

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*	Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L/M/H	L	M	H	L	M	H	

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Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P					P	P	Criterion 2: The document contains generic procedures that are applicable to any UAS. The level of complexity cannot be judged.

Notes: Operations – General
The document contains a comprehensive list of operational procedures and best practises for operators and remote crew involved in UAS operations. Potentially all UAS operation are covered by the standard, including autonomous flights. Contingency and emergency procedures are not addressed in detail.
The standard includes recurring crew resource management (CRM) training program for the flight crew. However, human error is only addressed vaguely, stating that it may be managed by a safety policy.

3.12.1 Assurance Coverage Detail

Table 208

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L/M/H			L	M	H	L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P							

Notes: Operations – General
The standard does not provide detailed guidance to develop procedures covering each of the required elements, in particularthe standard does not address contingency and emergency procedures exhaustively. No instructions/procedures on how to conduct dedicated (flight) tests are given.
The standard could be used as the basis for an audit conducted by an ISO notified body.

3.12.2Gaps

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3.12.2.1 Summary

Table 209 Gap Summary - OSO 08, 11, 14, 21

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	No evidence of standards covering requirements for each element. In addition, some elements (i.e. contingency procedures or pre and post-flight inspection) may require specific standards for each type of UAS and related operation.	-7	It is strongly recommended to develop standards covering all the operational aspects
2	No evidence at this stage of standards covering requirements to better address the functions of crew in relation to interactions with other entities involved in UAS operations. In particular, no evidence of standard procedures with ATM or other airspace authorities (e.g. CAA, …)	0	It is recommended to develop standards to define the activities of relation with other units, especially with ATM.
3	No evidence of standards covering contingency or emergency procedures in detail. In particular, standards should be defined for procedures with ATM and enforcement authority units	-5	It is strongly recommended to develop standards to define emergency/contingency procedures
4	Absence of standards covering requirements for checklists or manuals, appropriate for staff personnel in doing standardised operational procedures (e.g. flight planning procedures, operational manual, etc.)	-9	The operational procedures are the focus of aviation activities and shall be the same for UAS. It is very strongly recommended to develop a standard covering this issue.
5	No evidence of standards covering operational procedures to manage human errors, either during normal operations or emergency/contingency conditions	-9	Human errors are the most relevant issue in the occurrences. It is very strongly recommended to develop a standard covering this issue.
6	Absence of standards covering any requirements to train the Remote Crew through Crew Resource Management programmes, leading them to acquire the required competence.	-1	CRM is an adding value in conducting UAS operations. CRM training should be included in the curriculum for remote crews.

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3.12.2.2 Details

Table 210

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	No evidence of standards covering requirements for each element. In addition, some elements (i.e. contingency procedures or pre and post-flight inspection) may require specific standards for each type of UAS and related operation.	Safety (3)	Very High	The majority of aeronautical activities are managed following very specific procedures, as standard as possible, in order to enhance the safety aspects. Use of standard procedures for each specific issue may also support authorities to perform their supervision functions. Therefore, requirements should be developed for each single activity and applied by the UAS operators.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standards for standard procedures may be covered with an initial hard work. On the other side, when realised, the procedures may make easier the operations, cutting the costs.	0	0
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	Negative	The absence of requirements, may have consequences for industries in developing and producing different equipment.	-1	-1
		Social Acceptance (1)	No impact	-	0	0

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Total Weighted Score	**-7**

Table 211

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	No evidence at this stage of standards covering requirements to better address the functions of crew in relation to interactions with other entities involved in UAS operations. In particular, no evidence of standard procedures with ATM or other airspace authorities (e.g. CAA, …)	Safety (3)	High	In aviation, roles, functions and related responsibilities are usually structured in order to work in a more efficient and effective way. Furthermore, this issue may be sensitive in case of relation with Authorities or with ATM units. The procedures with ATM need to be very standardised in order to avoid misunderstandings and to simply the respective functions and reducing the workload. In addition, it's to be considered that Operators and crews operate in different context related to classification of airspace and/or different States.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Low	Costs are to be considered to realise the procedures and to train the personnel to apply.	+1	+2
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	No impact	-	0	0

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		Social Acceptance (1)	Low	Standard operational procedures are appreciated.	+1	+1
Total Weighted Score						**0**

Table 212

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	No evidence of standards covering contingency or emergency procedures in detail. In particular, standards for procedures with ATM and enforcement authority units should be defined	Safety (3)	High	Contingency and emergency conditions need to be standardised in order to apply the "best" way to handle them, following same parameters for the different situations. In the ATM, this aspect is very sensitive and standard contingency/emergency procedures may support ATM personnel to manage the complete situation, even in relation to other airspace users.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	Costs are to be considered to realise the procedures and to train the personnel to apply.	0	0
		Environmental Impact (1)	Bad	The absence of requirements may have consequence in third parties, in particular, on the ground.	-2	-2
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	The absence of emergency/contingency procedures gives less trust to citizens	-1	-1
Total Weighted Score						**-7**

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Table 213

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
4	Absence of standards covering requirements for checklists or manual, appropriate for staff personnel in doing standardised operational procedures (e.g. flight planning procedures, operational manual, etc.)	Safety (3)	Very high	Normal working operations in aviation context are "standard operations" and need to be known and followed by all personnel involved. The absence of standards is very sensitive for safety	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	The company could have limited extra costs to train personnel on procedures.	0	0
		Environmental Impact (1)	Bad	Operational procedures conducted in different ways may create problems for safety of third parties.	-2	-2
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	No standard operational procedures may be negatively considered and, as consequence, scarce social acceptance	-1	-1
Total Weighted Score						-9

Table 214

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score

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5	No evidence of standards covering operational procedures to manage human errors, either during normal operations or emergency/contingency conditions	Safety (3)	Very high	Human errors are, in the aviation world, the main cause of occurrences. The absence of standard procedures to check this aspect may have relevant consequences on safety for personnel involved in the operations and for third parties (on the ground and in the airspace, people and goods)	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	The company could have limited extra costs to train personnel on procedures.	0	0
		Environmental Impact (1)	Bad	Operational procedures conducted in different ways may create problems for safety of third parties.	-2	-2
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	No standard operational procedures may be negatively considered and, as consequence, scarce social acceptance	-1	-1
Total Weighted Score						**-9**

Table 215

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
6	Absence of standards covering any requirements to train the Remote Crew	Safety (3)	Very High	When operations are conducted by more of one person, CRM is relevant to better merge the functions of each person.	-1	-3

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	with Crew Resource Management knowledge	Cost of compliance to the requirement with a lack standard (2)	Low	If personnel have an adequate competence, the company could have very limited extra costs to train personnel in CRM.	+1	+2
		Environmental Impact (1)	Neutral	-	0	0
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	No impact	-	0	0
Total Weighted Score						**-1**

3.12.3 Conclusions and Recommendations

The gap assessment highlights the necessity to develop standards to cover all the gaps, in particular gap 1, 3,4 and 5.
ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures contains a comprehensive list of operational procedures and best practises for operators and remote crew involved in UAS operations. Potentially all UAS operations will be covered by the standard, including autonomous flights, while contingency and emergency procedures are not addressed in detail. However, the standard only provides high-level guidance, and should be complemented with case-specific operational procedures according to the application.
The EUROCAE MASPS provide detailed operational, covering minimum aviation system performance and interoperability requirements for the implementation of the ATOL, automatic taxiing and A&ER systems of a fixed-wing RPAS operating in non-segregated, military and civilian, terminal areas and airfields under IFR in different meteorological conditions without visual assistance ofc the remote pilot. These documents are not recommended as they are too mission-specific and not proportional to small operators.
In addition, SAE is developing standards addressing specific operational procedures associated to specific-use cases such as night operations, power line inspections and aerial photography, possibly providing best practices ad hoc for such operations.

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Table 216 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Procedure definition)	Low/Medium/High	Partial	ISO 21384-3: Operational Procedures	This standard only provides high level guidance. It should be complemented by more detailed guidance for specific applications.	8	No standards providing detailed guidance to develop procedure covering each of the required elements.
Criterion #2 (Procedure complexity)	Low	N.A.	NO STANDARD REQUIRED			
	Medium	N.A.	NO STANDARD REQUIRED			
	High	N.A.	NO STANDARD REQUIRED			
Criterion #3 (Consideration of Potential Human Error)	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3: Operational Procedures	This standard only provides high level guidance. It should be complemented by more detailed guidance for specific applications.	2	No standards providing detailed guidance to develop procedure covering each of the required elements.
	High	Partial				

Table 217 Recommended Standards - Assurance

Assurance

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Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criteria	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3: Operational Procedures	This standard only provides high level guidance. It should be complemented by more detailed guidance for specific applications.	2	No standards providing detailed guidance to develop procedure covering each of the required elements.
	High	Full				

3.13 *OSO 09, 15, 22* – Remote Crew Competencies

- OSO #09 - Remote crew trained and current and able to control the abnormal and emergency situations (i.e. Technical issue with the UAS)
- OSO #15 - Remote crew trained and current and able to control the abnormal and emergency situations (i.e. Human Error)
- OSO #22 - The remote crew is trained to identify critical environmental conditions and to avoid them

3.13.1 Requirement Description

Table 218 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The competency-based, theoretical and practical training ensures knowledge of: a. UAS regulation b. UAS airspace operating principles

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	Medium	c. Airmanship and aviation safety d. Human performance limitations e. Meteorology f. Navigation/Charts g. UA knowledge h. Operating procedures and is adequate for the operation.
	High	

Table 219 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	Training is self-declared
	Medium	Training syllabus is available The operator provides competency-based, theoretical and practical training
	High	A competent third party: • Validates the training syllabus • Verifies the remote crew competencies

3.13.2 Summary

Table 220 OSO 09, *15, 22* Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1* L	M	H
Integrity					
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	ISO 23665	P	P	P

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Recommendations for Remote Pilot Competency (RPC) for UAS Operations in category A (Open) and category B (Specific)	JARUS	N.A.	P	P	P
Assurance					
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 - 18		P	P
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	ISO 23665		P	P
Recommendations for Remote Pilot Competency (RPC) for UAS Operations in category A (Open) and category B (Specific)	JARUS	N.A.		P	P
Guide for Training and Equipping Visual Observers of Unmanned Aircraft Systems (VO Endorsement)	ASTM	WK62741		(P)	(P)

3.13.3 Integrity Coverage Detail

Table 221

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	ISO 23665	P	P	P	The document is limited to remote pilots trained for VLOS operations. Remote pilots involved in BVLOS operation are not covered. Other training aspects for personnel involved in UAS operations not covered.

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Notes: Personnel - Remote Pilot competence
The document, even if still not officially in force, is well structured and exhaustive.
The document, at this stage, includes only the Annex A to cover VLOS remote pilots training course. Further Annexes are expected to be realised to cover BVLOS operations and other typologies of UAS flights.
The Annex A is a very good guide-line, well detailed and covering a large part of the topics referred to a "VLOS remote pilot" training course.
The document reports in the chapter 3 "Terms and Definition" the definition of the *"Observer" – "remote crew member who, by visual observation of the unmanned aircraft, assists the remote pilot in the safe conduct of the flight"*.

Table 222

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A.	P	P	P	Does not contain training for visual observers.
The document developed by JARUS ad hoc to comply with the OSOs related to training. Currently, it is the unique document providing a training syllabus ad hoc for BVLOS operations.						

3.13.1 Assurance Coverage Detail

Table 223

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 - 18		P	P	Only general structure. No specific and detailed matters and topics

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Notes: Personnel - Remote Pilot competence
The document is a useful guideline defining the requirements for training and the development of training manuals for the unmanned aircraft systems (UAS) operator.
It reports the main chapters and sections to develop the structure of a manual.
It doesn't report the detailed matters, arguments and topics. Therefore, this standards covers the medium level of assurance.
The standard potentially cover any type of UAS (up to 600 kg) and operation.

Table 224

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	ISO 23665		P	P	The document is limited to remote pilots trained for VLOS operations. Remote pilots involved in BVLOS operation are not covered. Other training aspects for personnel involved in UAS operations not covered.

Notes: Personnel - Remote Pilot competence
The document, even if still not officially in force, is well structured and exhaustive.
The document, at this stage, includes only the Annex A to cover VLOS remote pilots training course. Further Annexes are expected to be realised to cover BVLOS operations and other typologies of UAS flights.
Compliance to this standard can serve as compliance to the assurance requirements by providing a training syllabus. Coverage is given as partial due to the BVLOS limitation.

Table 225

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A.		P	P	Does not contain training for visual observers.
The document developed by JARUS ad hoc to comply with the OSOs related to training. Compliance to this standard can serve as compliance to the assurance requirements by providing a training syllabus. Coverage is given as partial due to the visual observer limitation.						

Table 226

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guide for Training and Equipping Visual Observers of Unmanned Aircraft Systems (VO Endorsement)	ASTM	WK62741		(P)	(P)	This document is a Working Item int eh process of drafting.
This practice establishes the minimum training and equipment requirements, including general and field knowledge, skills, and abilities, for personnel who visually observe unmanned aircraft systems in flight.						

3.13.2 Gaps

3.13.2.1 Summary

Table 227 Gap Summary - OSO 09, *15, 22*

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	-7	It is strongly recommended to develop a standard covering training for visual observers, mainly for safety reasons.
2	Lack of standards covering training requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)	+6	No need to develop standards for remote crew not in charge of tasks related to the safe management of the flight.

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3.13.2.2 Details

Table 228

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	Safety (3)	High	In some UAS operations there might be personnel, other than remote pilot, who is responsible for the safe management of the flight. For instance, visual observers are key elements for EVLOS operations. Their role is to support the RPIC in the flight management, especially to remark presence of other hazards (e.g. other traffic, obstacles etc) when the drone is not in the LOS of the remote pilot.[4] Therefore, a training syllabus should be developed ad hoc for these professions to ensure that they have the necessary skills and competencies.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	The lack of standards makes more difficult and time consuming for training organisations and operators to develop a training programme[5].	-1	-2

[4] EU regulation 947/2019 establishes that visual observers "*assist the remote pilot in safely conducting the flight. Clear and effective communication shall be established between the pilot and the observer*".

[5] EU Regulation 947/2019 establishes that "*personnel in charge of duties essential to the UAS operation, other than remote pilot itself, have completed the on-the-job training developed by the operator*".

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				At the same time, it is time consuming for oversight authorities to check skills and competencies.		
		Environmental Impact (1)	Not applicable		0	0
		Impact on EU Industry competitiveness (1)	Negative	The adoption of standards could foster the demand for training organisations to deliver ad hoc courses.	-1	-1
		Social Acceptance (1)	Negative	As the role of the observers is important in certain phases of the flight, people may be concerned about the fact that there are no specific training requirements, especially for flights in urban environment.	-1	-1
Total Weighted Score						**-7**

Table 229

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards covering training requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)	Safety (3)	Low	The lack of standards for training of non-regulated professions has a minor impact on safety with respect of regulated professions. Usually supporting personnel (e.g. payload operator) does not have direct responsibilities in the flight management and is not even necessary in most UAS operations.	+1	+3
		Cost of compliance to the requirement with a lack standard (2)	Very low	As no formal training is prescribed by regulations for non-regulated professions, the lack of standards is not expected to generate extra costs for operators. Conversely the adoption of a standard would generate additional cost.	+2	+4
		Environmental Impact (1)	Not applicable		0	0

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		Impact on EU Industry competitiveness (1)	Negative	The adoption of standards could foster the demand for training organisations to deliver ad hoc courses.	-1	-1
		Social Acceptance (1)	No Impact	No impact foreseen on social acceptance.	0	0
Total Weighted Score						+6

3.13.3 Conclusions and Recommendations

The UAS crew and operators training is still under development due to the related regulation not being fully developed and implemented yet. Documents are often based on national regulations and standard requirements are not applied.
At this stage, some international Standards Making Bodies are working to develop standard requirements for training of personnel involved in the UAS activities.
Taking into account the UAS regulatory framework, the functions and responsibilities of people involved in VLOS operations seem to be better defined compared to people involved in BVLOS operations.
The gap assessment highlights the necessity to develop standards to fill the first gap for safety reasons. It is expected that future amendments of ISO 23665 (Training requirements for UAS personnel) will include training for semi-regulated roles (including visual observers). While it is still a draft, the document seems to be well structured to define the requirements for VLOS remote pilots training course. Annex A is a very good guideline, well detailed and covering a large part of the topics referred to a "VLOS remote pilot" training course. It is one of the rare documents reporting the definition of "Observer".
ASTM F3330-18 could be a valid standard for the development of an operator training program for the medium level of assurance. In addition, ASTM has initiated the work item WK62741 for the development of training for UAS visual observer.
The JARUS recommendations for Recommendations for remote pilot competency (RPC) are specifically developed to cover OSO 9,15,22 and can be assumed as the best reference. None of the analysed documents cover specific aspects related to UAS operations such as Security and Privacy aspects.

Table 230 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps

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Criterion #1	Low Medium High	Partial	JARUS Recommendations for RPC	It does not include training requirements for semi and non-regulated professions but covers lots the training assurance for PIC extensively.	8	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight
			ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	Does not cover training for BVLOS operations.	4	Lack of standards covering training requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)

Table 231 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	JARUS Recommendations for RPC	It does not include training requirements for semi and non-regulated professions but covers lots the training assurance for PIC extensively.	8	It does not include training requirements for semi and non-regulated professions, but covers lots the training assurance for PIC extensively.
			ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	Does not cover training for BVLOS operations.	4	Lack of standards covering training assurance requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)

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			ASTM F3330-18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator		4	Only general structure. No specific and detailed matters and topics.
	High	Partial	JARUS Recommendations for RPC	It does not include training requirements for semi and non-regulated professions but covers lots the training assurance for PIC extensively.	8	It does not include training requirements for semi and non-regulated professions but covers lots the training assurance for PIC extensively.
			ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations	Does not cover training for BVLOS operations.	4	Lack of standards covering training assurance requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)
			ASTM F3330-18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator		6	Only general structure. No specific and detailed matters and topics.

3.14 *OSO 10, 12* – Safe recovery from technical issues

- OSO #10 - Safe recovery from technical issue
- OSO #12 - The UAS is designed to manage the deterioration of external systems supporting UAS operation

3.14.1 Requirement Description

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Table 232 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion 1	Low	When operating over populous areas or gatherings of people, it can be reasonably expected that a fatality will not occur from any probable failure of the UAS or any external system supporting the operation For the purpose of this assessment, the term "probable" should be interpreted in a qualitative way as, "Anticipated to occur one or more times during the entire system/operational life of an UAS". Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed to aviation industry best practices
	Medium	When operating over populous areas or gatherings of people, it can be reasonably expected that a fatality will not occur from any single failure of the UAS or any external system supporting the operation. Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could directly lead to a failure affecting the operation in such a way that it can be reasonably expected that a fatality will occur are developed to a standard considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority. Some structural or mechanical failures may be excluded from the no single failure criterion if it can be shown that these mechanical parts were designed to a standard considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. National Aviation Authorities (NAAs) may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.
	High	Same as medium.

Table 233 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion 1	Low	A design and installation appraisal is available. In particular, this appraisal shows that: • the design and installation features (independence, separation and redundancy) satisfy the low integrity criterion; • particular risks relevant to the ConOps (e.g. hail, ice, snow, electro-magnetic interference…) do not violate the independence claims, if any.

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	Medium	Same as low. In addition, the level of integrity claimed is substantiated by analysis and/or test data with supporting evidence.
	High	Same as medium. In addition, a competent third party validates the level of integrity claimed.

3.14.2 Summary

Table 234 OSO 10, 12 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity/Assurance					
Guidelines for Development of Civil Aircraft and Systems	EUROCAE/SAE	ED-79A/ARP4754A	P	P	P
Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761	P	P	P
Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3230-17	P	P	P
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3309	P	P	P
Software Considerations in Airborne Systems and Equipment Certification	EUROCAE/RTCA	ED 12/DO-178	P	P	P
Design Assurance Guidance for Airborne Electronic Hardware	EUROCAE/RTCA	ED-80/DO-254	P	P	P
Standard Specification for Design, Construction, and Verification of Fixed-Wing Unmanned Aircraft Systems (UAS)	ASTM	F3298 -19	P	P	P
System Safety Analysis and Assessment for Part 23 Airplanes	FAA	AC 23.1309-1E	F	F	F
Safety Assessment of Remotely Piloted Aircraft Systems	JARUS	RPAS 1309	P	P	P

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Standard Practice for Methods to Safely Bound Flight Behavior of Unmanned Aircraft Systems Containing Complex Functions	ASTM	F3269	P	P	P

3.14.3 Coverage Detail

Table 235

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines for Development of Civil Aircraft and Systems	EUROCAE/SAE	ED-79A/ARP4754A	P	P	P	It does not include specific coverage of detailed software or electronic hardware development, safety assessment processes, in-service safety activities, aircraft structural development nor does it address the development of the Master Minimum Equipment List (MMEL) or Configuration Deviation List (CDL). More detailed information are to be found in referenced standards. Therefore, this standard is classified as partial.

Notes:
This document discusses the development of aircraft systems taking into account the overall aircraft operating environment and functions. This includes validation of requirements and verification of the design implementation for certification and product assurance. It provides practices for showing compliance with the regulations and serves to assist a company in developing and meeting its own internal standards by considering the guidelines herein. This document addresses the development cycle for aircraft and systems that implement aircraft functions.

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Table 236

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761	P	P	P	

Notes:
This document describes guidelines and methods of performing the safety assessment for certification of civil aircraft. It is primarily associated with showing compliance with FAR/JAR 25.1309. The methods outlined here identify a systematic means, but not the only means, to show compliance. A subset of this material may be applicable to non-25.1309 equipment. The concept of Aircraft Level Safety Assessment is introduced and the tools to accomplish this task are outlined. The overall aircraft operating environment is considered. This standard addresses particular risk analysis as required by SORA.

Table 237

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3230-17	P	P	P	

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Notes:

This practice covers internationally accepted methods for conducting safety assessments of systems and equipment for "small" aircraft.

Table 238

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft		F3309	P	P	P	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.

Notes: This standard defines a simplified safety assessment strategy which could be used for UAS. It establishes a minimum set of activities and artefacts which have to be conducted and produced. Those activities are also classified concerning the corresponding hazard class. This supports system safety in an early development phase.

Table 239

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Software Considerations in Airborne Systems and Equipment Certification	EUROCAE/RTCA	ED 12/DO-178	P	P	P	The purpose of this document is to provide guidance for the production of software for airborne systems and equipment that performs its intended function with a level of confidence in safety that complies with airworthiness requirements. The associated design assurance level for items results from system requirements. Since this standard only addresses software aspects the standards is classified as partial. This standard only addresses software.

Notes:

1. Published
2. The standard discusses those aspects of certification that pertain to the production of software for airborne systems and equipment used on aircraft, engines, propellers and, by region, auxiliary power units.

Table 240

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Design Assurance Guidance for Airborne Electronic Hardware	RTCA/EUROCAE	DO-254/ED-80	P	P	P	The purpose of this document is to provide guidance for the production of hardware for airborne systems and equipment that performs its intended function with a level of confidence in safety that complies with airworthiness requirements. The associated design assurance level for items results from system requirements. This standard does not include analysis of random hardware failures. Therefore a probabilistic risk assessment should be conducted in addition. Since this standard only addresses hardware aspects the standards is classified as partial. This standard is a set of considerations for hardware design which should be used together with other standards in order to fulfil safety requirements.

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Notes:
1. Published
2. The standard provides guidance for design assurance of airborne electronic hardware. It use might be too demanding for Medium Robustness.

Table 241

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Design, Construction, and Lightweight UAS		F3298-19	P	P	P	Requirements mitigating particular risks taking external factors into account such common cause failures are not explicitly addressed. Standard defines requirements on safety relevant subsystems of UAS. Software (SW) and airborne electronic hardware (AEH) considerations of systems supporting UAS operations are not explicitly included (e.g. treatment of use of complex electronic hardware (CEH) items).

Notes:
The standard contains requirements and aspects related to OSO#10:
- Construction
- Design Considerations
- Structure
- Verification methods

Table 242

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
System Safety Analysis and Assessment for Part 23 Airplanes		AC 25.1309-1E	F	F	F	

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Notes: This standard identifies baseline tasks in the system safety analysis and assessment applicable to part 23 airplanes. Those standard tasks are also applicable to UAS and therefore the requirements concerning system safety of OSO#10 are fully covered in all robustness levels.

Table 243

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Safety Assessment of Remotely Piloted Aircraft Systems	JARUS	AMC RPAS 1309	P	P	P	

Notes: This standard describes airworthiness requirements; the requirements are also valid to ensure safety as required by the OSO. It defines complexity levels of UAS, system availability and integrity requirements to maintain safe flight and landing, failure conditions classification and probability targets, availability and integrity requirements for systems to maintain safe aircraft separation and system safety assessment process.

Table 244

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Practice for Methods to Safely Bound Flight Behaviour of Unmanned Aircraft Systems Containing Complex Functions		F3269	P	P	P	Structural or mechanical failures are only considered as reflected by supervision and corresponding contingencies.

Notes: The standard describes reference architecture for safely bounding flight behaviour. As such it can be used to monitor/supervise external as well as internal systems and prevent single points of failures and initiate potential contingencies. Applicants could benefit if the competent authorities accept this standard as an acceptable means of compliance against single point of failure. The design automatically supports independence, separation and redundancy.
A suitable contingency/redundancy/mitigation must be available and executable.

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3.14.4 Gaps

No gaps were identified in OSO 10 and 12. Several documents cover the requirement partially and focus on different aspects. In combination these standards may fully fulfil the requirement. ASTM F3309 is considered relevant for all robustness levels. It may be combined with a standard for risk analysis and/or development process, especially for higher robustness. For analysis of risks several standards (e.g. ARP4761) may be considered, for the development process ED-79 may be considered appropriate. There are no standards explicitly addressing external systems. However, the safety analysis methods in use are applicable to such systems as well.

3.14.5 Conclusions and Recommendations

Table 245 Recommended Standards

Integrity/Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion	Low	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	6	Development error/process Risk Analysis

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			F3230-17: Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft	This practice covers internationally accepted methods for conducting safety assessments of systems and equipment for "small" aircraft. This standard provides a similar process as ASTM F3309, which was found to be more applicable to the other robustnesses.	4	Development error/process Risk Analysis
	Medium	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	8	Development error/process. Explicit Risk Analysis
	High	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	8	Development error/process Risk Analysis

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			ED-79A/ARP4754A: Guidelines for Development of Civil Aircraft and Systems	This document discusses the development of aircraft systems taking into account the overall aircraft operating environment and functions. This includes validation of requirements and verification of the design implementation for certification and product assurance. It provides practices for showing compliance with the regulations and serves to assist a company in developing and meeting its own internal standards by considering the guidelines herein. This document addresses the development cycle for aircraft and systems that implement aircraft functions.	6	Risk Analysis
			ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	This document describes guidelines and methods of performing the safety assessment for certification of civil aircraft. It is primarily associated with showing compliance with FAR/JAR 25.1309. The methods outlined here identify a systematic means, but not the only means, to show compliance. A subset of this material may be applicable to non-25.1309 equipment. The concept of Aircraft Level Safety Assessment is introduced and the tools to accomplish this task are outlined. The overall aircraft operating environment is considered. This standard addresses particular risk analysis as required by SORA.	6	Focus on risk analysis and safety assessment.

3.15 *OSO 13* – External services supporting UAS operations are adequate to the operation

3.15.1 Requirement Description

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Table 246 Integrity Requirements' Description

Criterion	Robustness	Description
Criteria	Low Medium High	The applicant ensures that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. If the externally provided service requires communication between the operator and service provider, the applicant ensures there is effective communication to support the service provisions. Roles and responsibilities between the applicant and the external service provider are defined.

Table 247 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion	Low	The applicant declares that the requested level of performance for any externally provided service necessary for the safety of the flight is achieved (without evidence being necessarily available).
	Medium	The applicant has supporting evidence that the required level of performance for any externally provided service required for safety of the flight can be achieved for the full duration of the mission. This may take the form of a service-level agreement (SLA) or any official commitment that prevails between a service provider and the applicant on the relevant aspects of the service (including quality, availability, responsibilities). The applicant has a means to monitor externally provided services which affect flight critical systems and take appropriate actions if real-time performance could lead to the loss of control of the operation.
	High	Same as medium. In addition: • the evidence of the performance of an externally provided service is achieved through demonstrations; and • a competent third party validates the claimed level of integrity.

3.15.2 Summary

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO. 824292.

Table 248 OSO 13 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity					
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	
Unmanned aircraft systems -- Part 2: Product systems	ISO	21384-2		P	
Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part1- Definitions and system engineering procedures for the establishment and assessment of performance	EN	16803-1:2016		P	
Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals	EN	16803-2:2016		P	
Space systems — Space-based service for a positioning system with high accuracy and safety support applications in low visibility due to weather conditions	ISO	CD 22591.2		P	
Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.	AESA	N.A.		P	
Guidelines for the use of multi-GNSS solutions for UAS	EUROCAE	N.A.		P	
Requirements for UTM services and service providers	ISO	23629-12		P	
Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	ASTM	WK69690		P	
Assurance					
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P
Requirements for UTM services and service providers	ISO	23629-12		P	P
Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	ASTM	WK69690		P	P

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3.15.3 Integrity Coverage Detail

Table 249

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P			-Adequacy for the intended operation. -Specific roles and requirements are not defined.

Notes:
The standard provides general operational procedures to ensure safety of UAS operations. Among these procedures it is advised to check the accuracy of GNSS as a function of the location and the environmental conditions.

Table 250

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 2: Product systems	ISO	21384-2	P			-Adequacy for the intended operation. -Specific roles and requirements are not defined.

Notes:
The standard provides requirements for ensuring the quality and safety of the design and manufacture of UAS. However, no technical requirements are provided so it remains unclear how to determine adequacy of navigation performance for the intended operation.
Conservatively, the standard could be compliant with low level of integrity (where adequacy of performance does not have to be demonstrated with tests, compliance with technical standards, etc.).

Table 251

Standard Title	SDO	Doc. Reference	Criterion 1	Gaps

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			L	M	H	
Space - Use of GNSS-based positioning for road Intelligent Transport Systems-Part1- Definitions and system engineering procedures for the establishment and assessment of performance	EN	16803-1:2016		P		-Missing criteria to define performance adequacy for a given drone operation -Roles and responsibilities

Notes:
The document contains a framework for GNSS applications. The standard is mainly addressed at the Road ITS domain, but definitions and metrics are applicable also to the UAS context.
Performance metrics are defined. An approach to define performance levels is proposed.
The standard could be used as informative guidance to better understand the general architecture of a GNSS system.
In addition, the document provides a classification of "reference GNSS environment" in which GNSS performance may vary. This definition is applicable to the context of drone operations as the "GNSS environment" is very similar to the Road domain.

Table 252

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Space - Use of GNSS-based positioning for road Intelligent Transport Systems-Part2- Assessment of basic performances of GNSS-based positioning terminals	EN	16803-2:2016		P		-Missing criteria to define performance adequacy for a given drone operation -Roles and responsibilities

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Notes:
The document contains procedures to assess the basic performances (i.e. availability, continuity, accuracy and integrity) of any GBPT (GNSS based positioning terminal) for a given use case.
However, the document does not define minimum performance requirements (i.e. it does not include MOPS) as these may vary depending on the type of application.
The proposed tests are specific for the road domain and not directly repeatable for drones. Some operational environment and dynamics are comparable (so that it could be possible to “adapt” the procedures), others are not (e.g. traffic congestion).
More similarities can be found between ground vehicles dynamics and multicopters (i.e. the possibility to have multiple stops along the route, etc.).
The metrics and the mathematical approach to derive performance requirement can be applied to the drone context.
In conclusion the standard offers an approach that can be adopted to derive performance of GNSS equipment but does not provide criteria to determine the adequacy of a given performance. Therefore, it can only partially fulfil OSO #13.

Table 253

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Space systems — Space-based service for a positioning system with high accuracy and safety support applications in low visibility due to weather conditions	ISO	CD 22591.2		P		-Adequacy for UAS operations -Roles and responsibilities

Notes:
The document contains safety, performance and HMI requirements for space-based positioning systems as support to applications in low visibility conditions. The targets of this standard are ground vehicles (e.g. employed in snowplow, docking,etc.) for which a high level of accuracy is needed to ensure safety of personnel.
Four different accuracy levels are proposed, up to centimeter level. Although drones are not supposed to fly in bad weather conditions, these performance levels could be relevant also for small UAS operating at VLL, possibly in proximity of obstacles/infrastructures (e.g. performing inspection missions, or delivery in urban environment).

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Table 254

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.	AESA	N.A.		P		Roles and responsibilities

Notes:
The document represents an AMC officially recognised by AESA (CAA of Spain) to comply with OSO #13 requirements. Different navigation performance levels are defined, distinguishing between VLOS/BVLOS conditions and flight above or below VLL.
Roles and responsibilities are not defined.

Table 255

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Guidelines for the use of multi-GNSS solutions for UAS	EUROCAE	N.A.		P		

Notes:
The document contains guidelines related to the use of GNSS in UAS operations and proposes approaches to fulfil OSO #13 requirements related to GNSS. Three different levels (Low, Medium, High) of navigation performance are proposed, possibly matching the SORA integrity requirements: values for accuracy, integrity, availability, continuity, etc. are provided.
In addition, possible causes for degradation of GNSS performance are provided, included their dependency with environmental conditions.
The document is just a preliminary guidance. It is expected that SG-62 will develop adequate standards (e.g. MOPS) for UAS GNSS equipment, taking into account the SORA approach and thus perfectly matching with the OSO #13 requirements.

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Table 256

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Requirements for UTM services and service providers	ISO	23629-12		P		Navigation service providers are not in the scope.

Notes:
The document is a Committee Draft with the aim to cover safety, security, privacy and quality requirements for UTM service providers, C2 Link service providers and communication (C2CSP) service providers.
This standard differentiates between safety-critical, safety-related and additional services. It could serve as point of reference for operators to identify safety-critical services.

Table 257

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	ASTM	WK69690		P		The draft is still under development and it is not sure whether roles and responsibilities are defined, as well as details on SLAs.

Notes:
This standards defines minimum performance standards for Surveillance Supplemental Data Service Providers (SDSP) equipment and services to UAS Service Suppliers/Providers (USS/USP) in a UAS Traffic Management (UTM) ecosystem. These surveillance services will provide aircraft track information to Detect and Avoid (DAA) systems to enable BLVOS UAS operations.
The draft is still under development and it is not sure whether roles and responsibilities are defined, as well as details on SLAs.

3.15.4 Assurance Coverage Detail

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Table 258

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P	No means to monitor externally provided services.

Notes:
Service level agreements are included in the list of suggested documentation to be held by UAS operator. Oversight of contracted service providers is needed to ensure quality and performance of safety-critical information
The standard covers at high level general operational requirement but it is unclear how to determine adequacy of navigation performance for the intended operation.

Table 259

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Requirements for UTM services and service providers	ISO	23629-12		P	P	Navigation service providers are not in the scope.

Notes:
This standard is aimed at service providers, so an operator may ensure that a service provider is compliant to this standard, rather than showing compliance itself. The operator may therefore require the service provider to hold an ISO certification.

Table 260

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

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Surveillance UTM Supplemental Data Service Provider (SDSP) Performance	ASTM	WK69690		P	P	The draft is still under development and it is not sure whether roles and responsibilities are defined, as well as details on SLAs.
Notes: This standard is aimed at service providers, so an operator may ensure that a service provider is compliant to this standard, rather than showing compliance itself. The operator may therefore require the service provider to hold an ASTM certification.						

3.15.5 Gaps

3.15.5.1 Summary

Table 261 Gap Summary - OSO 13

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of specific taxonomy (e.g. RNP 0.02 or 0.0) to define GNSS performance adequacy specifically for drone operations.	-11	Several indicators (including ANSI Roadmap and the establishment of EUROCAE WG 105/SG 62) show that there is the urgency to develop standards to cover this gap. Work is on-going at EUROCAE level as WG 105/ SG 62 should publish in the future standards related to use of GNSS for drone applications. Some metrics have already been published by EUROCAE, CEN, ISO and AESA but only at level of guidelines.
2	Lack of standardised procedures for the monitoring of external services.	2	There is no particular need to have standards covering this gap. For operations dealing with low SAILs (i.e. with a low level of robustness) it will be sufficient for operators to refer to the GNSS open services document definition. For high-risk operations, standard procedures to monitor GNSS performance should be defined.
3	Lack of testing procedures to demonstrate that GNSS performance is adequate for UAS OPS.	-8	It is recommended to develop a standard dedicated to testing procedures for drone GNSS related applications. CEN prEN 16803-2 can be used as model to produce a similar standard for drones.

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3.15.5.2 Details

Table 262

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of specific taxonomy (e.g. RNP 0.02 or 0.0) to define GNSS performance adequacy specifically for drone operations.	Safety (3)	Very High	GNSS performance is a crucial element to support UAS operations. Accurate tracking solutions enabled by GNSS are critical for reducing operational risks and complying with SORA. GNSS performance depends on several factors, including environment, altitude, location, weather etc. In addition, depending on the type of operation, different GNSS performance levels would be needed. For instance, performance levels to be ensured for BVLOS mission in urban areas and/or in proximity of obstacles would are different from those that might be needed for BVLOS missions over a sparsely populated environment. High reliability, robustness and accuracy are essential in ensuring that accurate position information on the drone is available and that beyond line of sight operations can be conducted safely. In addition, GNSS supports geofencing functions that are essential to remain inside the predefined volume. In absence of precise metrics, it is hard for operators to understand to what extent the available GNSS performance is able to safely support their missions.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	High	In absence of standards, it takes longer for operators to understand whether the GNSS performance is adequate for the operations. On the other hand, it will be more time consuming for Authorities to verify adequacy of GNSS performance.	-1	-2

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		Environmental Impact (1)	Bad	The use of GNSS contributes to reduce traffic congestion and improve the efficiency of transportation through navigation, fleet management, opportunities and satellite traffic monitoring. The enhanced positioning capabilities of EGNSS could be a key element in the safe and sustainable development of autonomous drones, helping to further reduce congestion and pollution.	-2	-2
		Impact on EU Industry competitiveness (1)	Very Negative	The 2019 GNSS market report shows that the GNSS is the key to unlock the drone market. GNSS positioning information will enable safe and harmonious drone market growth. The number of GNSS devices shipped on these drones has greatly increased in recent years, especially starting in 2015 when prices had decreased sufficiently for consumer drones to become more widely available. The Shipments of GNSS devices by drone category have reached the 11 million units in 2018 and are expected to grow more. In addition, GNSS is one of the main enablers for BVLOS missions and several European companies have been developing drones with beyond visual line of sight capabilities (e.g. Airbus, Delar-Tech etc.) In general, it is estimated that the global GNSS downstream market revenues from both devices and services are forecast to grow from €150 billion in 2019 to €325 billion in 2029. This growth is mainly due to revenues from mass market and mid-end devices (<€150) and from augmentation services.	-2	-2
		Social Acceptance (1)	Positive	As GNSS is an important element to manage and increase efficiency of drone traffic, reduce emissions and power consumption. This aspect is socially relevant.	1	1

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				However, enabling a large number of drone missions in populated areas may be seen in a negative way from part of the public opinion as these intrinsically represent a significant element of risk.		
Total Weighted Score						**-11**

Table 263

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standardised procedures for the monitoring of external services	Safety (3)	Low	During flight operations, the GNSS level is monitored through the GCS. In case of poor signal, failsafe procedures can be activated (either manually or automatically). These procedures are widely adopted by most commercial drones to allow a safe recovery of the UAS.	1	3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standard procedures to monitor GNSS signal will cause each pilot to become confident and trained with monitoring systems used on a case by case basis. In addition, specific HMI evaluation might be required.	0	0
		Environmental Impact (1)	No impact		0	0
		Impact on EU Industry competitiveness (1)	Negative	The lack of standards to monitor GNSS signal makes difficult for industries to produce harmonised solutions (e.g. design of RPS interfaces and functions).	-1	-1
		Social Acceptance (1)	No impact		0	0
Total Weighted Score						**+2**

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Table 264

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	Lack of testing procedures to demonstrate that GNSS performance is adequate for UAS OPS.	Safety (3)	High	For high assurance it is required to demsontrate somehow that the desired performance level is achieved. The absence of standard procedures might lead operators to perform inaccurate or incomplete tests.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	Validation by competent third parties would take much time to check compliance. I addition operators may dedicate some effort in defining from scratch the test campaign.	-1	-2
		Environmental Impact (1)	Bad	Standards may improve tests efficiency (e.g. by optimising the number of tests to be done) and consequently reduce the energy consumption and emissions.	-2	-2
		Impact on EU Industry competitiveness (1)	No impact		0	0
		Social Acceptance (1)	Negative	In case of accident/incident due to GNSS issues, the lack of standard testing procedures may have a negative impact on public opinion.	-1	-1
Total Weighted Score						-8

3.15.6 Conclusions and Recommendations

This section contains an assessment of the standards to support compliance with the requirements defined in OSO #13, with particular focus on the adequacy of navigation services.

Performance level:

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Navigation performance is essential to ensure safety of UAS operations. The reliability of navigation data affects the capacity of correctly following a predefined flight trajectory (automatic flight modes) but also the robustness of the geofencing functionality.
The assessment for OSO #13 shows that there is a lack of standards tailored for UAS applications, confirming the analysis carried out by ANSI in December 2018. In fact, existing standards mainly deal with traditional manned aviation applications (e.g. RTCA DO-316). Although the definition of performance metrics (i.e. accuracy, availability, integrity etc.) is similar, performance requirements and test procedures are not directly applicable to UAS given the different flight dynamics and operational context (low altitudes, lower ground speed, etc...).
Some standards imported from domains other than aviation (e.g. road) define accuracy requirements that could be suitable especially for UAS operations at VLL. Although the operational target is different, the environmental conditions are similar (urban canyons, dynamics, etc.) However, OSO #13 requires demonstrating that navigation performance is adequate for the "intended UAS operation". This means that an operator, depending on the envisaged UAS mission, shall demonstrate that navigation performance is adequate to ensure safety. It is therefore necessary to have standards that can map performance requirements to typical-use cases and environment.
The performance level for a give operation may be:

- Derived from regulations/standards (AESA has developed specific AMC to comply with OSO#13 requirements (at least at navigation performance level)
- Determined by the operator on a case-by case basis (a recognised methodology should be defined in this case)

The prEN 16803-x series provides some definitions and test methods to measure the performance of GNSS in the Road ITS domain. While intended for vehicle use, most dynamic parameters of the former are comparable to those of drones, as well as environmental conditions (i.e. operations in urban canyons at low altitudes). Therefore, some of the procedures and scenarios defined in such documents could be considered as a baseline to develop tests for drones.
As a further remark, there is general lack of criteria to evaluate the adequacy of a given performance for a specific mission. There is the need for a standard or a guideline to define reference values in terms of GNSS performance for low, medium and high integrity. For each of these levels, distinction should be made depending on the type of operation.

<u>Roles and responsibilities:</u>

The definition of roles and responsibilities between operators and service providers in "contracting" navigation services is not regulated (this could be relevant when the operator will require access to non-open services such as GALILEO PRS and HAS). SORA Annex E states that "*requirements for contracting services with Service Providers may be derived from ICAO Standards and Recommended Practices - SARPS (currently under development)".* In general ICAO SARPs for GNSS are not applicable for UAS (given the different phases of flight, dynamics, environment, etc) and, moreover, no GNSS-specific SARPS for UAS are currently under development. Rather than having specific standards, this aspect should be regulated at ICAO/EU level.

<u>Assurance:</u>

For medium assurance the operator shall provide evidence that the claimed level of integrity is achieved.

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In this case evidence of performance relies on two elements:

- Performance that can be delivered by the GNSS receiver (this can be inferred by the technical data sheet)
- Performance delivered by the GNSS constellation and service provider (this can be inferred by the respective Service Definition Documents)

It is further required to have means to monitor GNSS performance during the flight. Currently such procedure is not yet standardised.
For high integrity, there is the need to implement standards defining procedures to demonstrate that the service performance is achieved.
This requirement can be partially covered by the CEN prEN 16803-2 as it provides some testing procedures for GNSS receivers for the road domain.

Other

Cyber security is also a relevant issue for GNSS. On-going standardisation activities are working on GNSS attacks (not necessarily for drone applications). However, since security issues are not part of the current version of the SORA, such standards are not considered in this analysis.
EUROCAE has established the SG 62 in WG 105 with the purpose to develop standards on GNSS for UAS. The group published in June 2019 the "Guidelines for the use of multi-GNSS solutions for UAS". The document proposes approaches to fulfil requirements for OAS #13 (related to navigation) and seems to pave the way for the development of adequate standards tailored for drone applications, while keeping in consideration the SORA methodology. Therefore, it is strongly recommended to monitor the activities of this WG as it is expected that the emerging standards will match OSO requirements at least at equipment level (i.e. Performance of GNSS receiver). In addition, the guidelines propose three different performance layers for GNSS (low/medium/high) tailored to UAS operations.

Beside navigation, external services may include C2 Link providers and C2CSP providers (e.g. cellular networks). Requirements for such providers shall be established to ensure an adequate level of safety. ISO TC20/SC 16 has planned the development of a standard to cover safety, privacy, quality and security requirements for these providers, including U-Space providers that could represent an AMC for OSO #13 in the future (except for navigation performance that is out of scope).

Finally, the analysis carried out shows that there is a general lack of GNSS related standards tailored for UAS operations. It is strongly recommended to produce a standard (e.g. by EUROCAE WG 105/ SG 62) to define performance levels for different types drone operations. This gap has a very negative impact, especially on safety and market related aspects. In addition, a standard is needed to define specific performance tests on GNSS. This standard could be developed similarly to CEN 16803, in which some environmental conditions and flight dynamics are comparable with those of small drones.

Table 265 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps

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Criteria	Low Medium High	Partial	ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures		2	-Adequacy for the intended operation. -Specific roles and requirements are not defined.
			ISO 21384-2 - Unmanned aircraft systems -- Part 2: Product systems		2	-Adequacy for the intended operation. -Specific roles and requirements are not defined.
			16803-1:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part1- Definitions and system engineering procedures for the establishment and assessment of performance	Not tailored for small UAS	3	
			16803-2:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals	Not tailored for small UAS	1	
			Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.		8	Roles and responsibilities not defined
			Guidelines for the use of multi-GNSS solutions for UAS	Draft in internal consultation	3	
			ISO 23629-12 - Requirements for UTM services and service providers	Applicable to service providers	2	

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Table 266 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criteria	Low					
	Medium High	Partial	ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures		2	No means to monitor externally provided services.
			ISO 23629-12 - Requirements for UTM services and service providers	Applicable to service providers Committee Draft stage	2	

3.16 *OSO 16* – Multi crew coordination

3.16.1 Requirement Description

Table 267 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Procedures)	Low Medium	Procedure(s) to ensure coordination between the crew members and robust and effective communication channels is (are) available and at a minimum cover: (a) Assignment of tasks to the crew,

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Criterion	Robustness	Description
	High	(b) Establishment of step-by-step communications. *Note: The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see the table below).*
Criterion #2 (Training)	Low	Remote Crew training covers multi crew coordination
	Medium	Same as Low. In addition, the Remote Crew receives Crew Resource Management (CRM) training. *Note 1: In the context of the SORA, the term 'remote crew' refers to any person involved in the mission.* *Note 2: CRM training focuses on the effective use of all the remote crew to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*
	High	
Criterion #3 (Communication devices)	Low	N/A
	Medium	Communication devices comply with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority
	High	Communication devices are redundant and comply with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. *Note: This implies the provision of an extra device to cope with the failure of the first device.*

Table 268 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Procedures)	Low	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. (b) The adequacy of the procedures and checklists is declared.
	Medium	(a) Procedures are validated against standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority. (b) Adequacy of the procedures is proven through: (1) Dedicated flight tests, or (2) Simulation, provided the simulation is proven valid for the intended purpose with positive results.

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Criterion	Robustness	Description
	High	Same as Medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. (b) The procedures, flight tests and simulations are validated by a competent third party.
Criterion #2 (Training)	Low	Training is self-declared (with evidence available)
	Medium	(a) Training syllabus is available. (b) The operator provides competency-based, theoretical and practical training.
	High	A competent third party: (a) Validates the training syllabus. (b) Verifies the remote crew competencies.
Criterion #3 (Communication devices)	Low	The applicant declares that the required level of integrity has been achieved
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation, inspection, design review or through operational experience.
	High	EASA validates the claimed level of integrity.

On basis of these descriptions, the standards were assessed for the following on the basis whether or not it included additional (detailed) guidance or standards on:

- (Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) assignment of tasks to the crew (Criterion #1; L/M/H)
- (Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) step-by-step communications between crew members (Criterion #1; L/M/H)
- Multi crew coordination training (Criterion #2; L[6]/M/H)
- CRM training for all persons involved in the mission (Criterion #2; M/H)

[6] The assurance level for Low is 'Training is self-declared', but 'with evidence available' and hence it is included for the search of a standard.

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- Devices for communication between persons involved in the mission (Criterion #3;M/H)
- Flight tests or simulation to prove the adequacy of multi crew coordination (Criterion #1; M/H)
- Flight tests to prove de adequacy of multi crew coordination for the complete envelope (Criterion #1; H)
- Training syllabus for multi-crew coordination (Criterion #2; M)
- Competency-based theoretical and practical training of multi-crew coordination (Criterion #2; M).

3.16.2 Summary

Table 269 OSO 16 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*		
			L/M/H			L	M	H	L	M	H
Integrity/Assurance											
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	N/A	(P)	(P)	(P)	(P)	(P)	N/A	-	-
Architecture Framework for Unmanned Systems	SAE	AIR5665B	N/A	-	-	-	-	-	N/A	(P)	(P)
UAS Operator Compliance Audits	ASTM	WK62731	N/A	(P)	(P)	(P)	(P)	(P)	N/A	(P)	(P)
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707	N/A	-	-	(P)	(P)	(P)	N/A	-	-
Standard for Small Unmanned Aircraft Systems (sUAS) Used for Public Safety Operations	NFPA	2400	N/A	(P)	(P)	(P)	(P)	(P)	N/A	(P)	(P)
New Guide for Training UAS Visual Observers	ASTM	WK62741	N/A	-	-	(P)	(P)	(P)	N/A	-	-
Practice for Communications Procedures—Phonetics	ASTM	F1583	N/A	(P)	(P)	-	-	-	N/A	-	-

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3.16.3 Coverage Detail

Table 270

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	N/A	(P)	(P)	(P)	(P)	(P)	N/A	-	-	The standard is still under development in July 2020.
Notes: On basis of the Statement of Work, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).												

Table 271

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Architecture Framework for Unmanned Systems	SAE	AIR5665B	N/A	-	-	-	-	-	N/A	(P)	(P)	The abstract is insufficient to assess coverage.
Notes: On basis of the abstract, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).												

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Table 272

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
UAS Operator Compliance Audits	ASTM	WK62731	N/A	(P)	(P)	(P)	(P)	(P)	N/A	(P)	(P)	The standard is still under development in November 2020.

Notes:
On basis of the Statement of Work, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).

Table 273

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707	N/A	-	-	(P)	(P)	(P)	N/A	-	-	The abstract is insufficient to assess coverage.

Notes:
On basis of the summary, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).

Table 274

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard for Small Unmanned Aircraft Systems (sUAS) Used for Public Safety Operations	NFPA	2400	N/A	(P)	(P)	(P)	(P)	(P)	N/A	(P)	(P)	The abstract is insufficient to assess coverage. Limited to sUAS.

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Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Notes: On basis of the Document Scope, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).												

Table 275

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
New Guide for Training UAS Visual Observers	ASTM	WK62741	N/A	-	-	(P)	(P)	(P)	N/A	-	-	The standard is still under development in November 2020.
Notes: On basis of the Statement of Work, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).												

Table 276

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Practice for Communications Procedures—Phonetics		F1583	N/A	(P)	(P)	-	-	-	N/A	-	-	The abstract is insufficient to assess coverage.
Notes: On basis of the abstract, it could not be assessed to which extend it covers the criteria of OSO #16, and hence it scores (P).												

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3.16.4 Gaps

3.16.4.1 Summary

Criterion	ASTM WK62744*	SAE AIR5665B**	ASTM WK62731*	SAE ARP5707**	NFPA NFPA 2400*	ASTM WK62741*	ASTM F1583**	Gap?
(Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) assignment of tasks to the crew (Criterion 1; L/M/H)	?	-	?	-	?	-	?	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the assignment of tasks to the crew
(Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) step-by-step communications between crew members (Criterion 1; L/M/H)	?	-	?	-	?	-	?	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the step-by-step communications between crew members
Multi crew coordination training (Criterion 2; L/M/H)	?	-	?	?	?	?	-	Absence of standards for multi crew coordination training

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CRM training for all persons involved in the mission (Criterion 2; M/H)	?	-	?	?	?	?	-	Absence of standards for CRM training for all persons involved in the mission
Devices for communication between persons involved in the mission (Criterion 3;M/H)	-	?	?	-	?	-	-	Absence of standards for the devices for communication between persons involved in the mission
Flight tests or simulation to prove the adequacy of multi crew coordination (Criterion 1; M/H)	?	-	?	-	?	-	?	Absence of standards for flight tests or simulation to prove the adequacy of multi crew coordination
Flight tests to prove de adequacy of multi crew coordination for the complete envelope (Criterion 1; H)	?	-	?	-	?	-	?	Absence of standards for flight tests to prove de adequacy of multi crew coordination for the complete envelope
Training syllabus for multi-crew coordination (Criterion 2; M)	?	-	?	?	?	?	?	Absence of standards for the training syllabus for multi-crew coordination
Competency-based theoretical and practical training of multi-crew coordination (Criterion 2; M)	?	-	?	?	?	?	?	Absence of standards for competency-based theoretical and practical training of multi-crew coordination

* Could not be assessed because under development

** Could not assessed because only a summary available

Table 277 Gap Summary - OSO 16

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Absence of standards for the procedure(s) to ensure coordination between the crew members and	-6	It is recommended to develop a standard covering the assignment of tasks to the crew and the establishment of step-by-step communications, mainly for safety

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Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
	robust and effective communication channels cover the assignment of tasks to the crew		reasons. As an intermediate step, the sharing of good practices for various different operational characteristics (EVLOS/BVLOS/urban environment, etc.) may also be considered.
2	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the step-by-step communications between crew members	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for multi-crew operations in manned aviation may be considered and adapted to multi-crew operations of unmanned aircraft.
3	Absence of standards for multi crew coordination training	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for multi-crew operations in manned aviation may be considered and adapted to multi-crew operations of unmanned aircraft.
4	Absence of standards for CRM training for all persons involved in the mission	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for CRM training in manned aviation may be considered and adapted to multi-crew operations of unmanned aircraft.
5	Absence of standards for the devices for communication between persons involved in the mission	-7	It is recommended to develop a standard covering communication devices suitable for drone crews. As an intermediate step, standards for communication devices applied in manned aviation may be considered and adapted to accommodate specificities for drone crews stemming from different operational concepts (physical separation of crew members, ability of crew member to use/activate a communication device, need for full duplex communication, etc.).
6	Absence of standards for flight tests or simulation to prove the adequacy of multi crew coordination	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for flight tests or simulation to prove the adequacy of multi crew coordination in manned aviation may be considered and adapted to multi crew operations of unmanned aircraft.

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Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
7	Absence of standards for flight tests to prove de adequacy of multi crew coordination for the complete envelope	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for flight tests to prove de adequacy of multi crew coordination for the complete envelope in manned aviation may be considered and adapted to multi crew operations of unmanned aircraft.
8	Absence of standards for the training syllabus for multi-crew coordination	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for the training syllabus for multi-crew coordination in manned aviation may be considered and adapted to multi crew operations of unmanned aircraft.
9	Absence of standards for competency-based theoretical and practical training of multi-crew coordination	-6	It is recommended to develop a standard covering the coordination and communication between crew members. As an intermediate step, standards for competency-based theoretical and practical training of multi-crew coordination in manned aviation may be considered and adapted to multi crew operations of unmanned aircraft.

3.16.4.2 Details

Table 278

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the assignment of tasks to the crew	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure.	-2	-6

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				Therefore standards, or as an intermediate step, shared best practices are needed.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 279

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the step-by-step	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was	-2	-6

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	communications between crew members			overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 280

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	Absence of standards for multi crew coordination training	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked	-2	-6

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				in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 281

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
4	Absence of standards for CRM training for all persons involved in the mission	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a	0	0

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				standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation		
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 282

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
5	Absence of standards for the devices for communication between persons involved in the mission	Safety (3)	High	Aspects which are critical for communication devices and their appropriate use may be overlooked. Therefore standards, or as an intermediate step, shared best practices are needed.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	High	With missing standards, operators need to start from scratch by thinking through the required capabilities and performances of communication devices. Furthermore, the operator needs to liaise with communication devices manufacturers in order to find an appropriately matching device. This would not be an extra burden when a standard would already be available to which manufacturers have already devices available	-1	-2
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	Negative	A lack of standards for communication devices may fragment the devices manufacturers have to produce	-1	-1

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		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-7**

Table 283

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
6	Absence of standards for flight tests or simulation to prove the adequacy of multi crew coordination	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

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Table 284

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
7	Absence of standards for flight tests to prove de adequacy of multi crew coordination for the complete envelope	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 285

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
8	Absence of standards for the training	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In	-2	-6

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	syllabus for multi-crew coordination			an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 286

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
9	Absence of standards for competency-based theoretical and practical training of multi-crew coordination	Safety (3)	Very High	Aspects which are critical to the establishment of step-by-step communications and other associated aspects may be overlooked. In an unfortunate situation this may lead to a serious incident/accident with crew miscommunication as root cause as a critical aspect was overlooked in establishing a multi crew coordination procedure. Therefore standards, or as an intermediate step, shared best practices are needed.	-2	-6

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		Cost of compliance to the requirement with a lack standard (2)	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that is affected by multi crew coordination aspects. This would not be an extra burden when a standard would already be available which, possibly, may only need some minor adaptations to suit the specific operation	0	0
		Environmental Impact (1)	Neutral	No difference expected from a standard on crew communication	0	0
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

3.16.5 Conclusions and Recommendations

OSO #16 consists of 3 criteria of which criterion 1 (procedures) explicitly refers to standards. Some standards are currently being drafted and may partially or fully cover a criterion, or not at all. In order to give such standards 'the benefit of the doubt', they all are rated as 'partial coverage' indicated between brackets, i.e. as '(P)'. The same procedures was applied for standards for which only a scope description was available to the team (typically SAE) and that scope description suggests that the standard may partially or fully cover a criterion.

For none of the criteria of OSO #16 is a standard available. It is therefore recommended to develop standards covering:

- Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover (a) the assignment of tasks to the crew and (b) step-by-step communications between crew members
- Multi-crew coordination training
- CRM training for all persons involved in the mission
- The devices for communication between persons involved in the mission
- Absence of standards for flight tests or simulation to prove the adequacy of multi crew coordination

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- Absence of standards for flight tests to prove de adequacy of multi crew coordination for the complete envelope
- The training syllabus for multi-crew coordination
- Competency-based theoretical and practical training of multi-crew coordination.

As an intermediate step, it may be considered to adapt standards for multi-crew operations and communication devices applied in manned aviation, if due consideration is given to the differences between multi-crew operations in manned aviation and those in unmanned aviation. For example, in unmanned aviation the crew members may not be co-located or not simultaneously be on duty.

Table 287 Recommended Standards

Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 Procedures	Low	N.A.	NO STANDARD REQUIRED			
	Medium	(Partial)	None; potentially: ASTM WK62744 SAE AIR5665B ASTM WK62731 SAE ARP5707 NFPA 2400 ASTM WK62741 ASTM F1583	No appropriate standard available yet or available for review	N.A.	
	High				N.A.	

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Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #2 Training	Low	(Partial)	None; potentially: ASTM WK62744 SAE AIR5665B ASTM WK62731 SAE ARP5707 NFPA 2400 ASTM WK62741 ASTM F1583	No appropriate standard available yet or available for review	N.A.	• Absence of standards for the procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) step-by-step communications between crew members • Absence of standards for multi crew coordination training • Absence of standards for CRM training for all persons involved in the mission • Absence of standards for the training syllabus for multi-crew coordination • Absence of standards for competency-based theoretical and practical training of multi-crew coordination
	Medium				N.A.	
	High				N.A.	
Criterion #3 Communication devices	Low		NO STANDARD REQUIRED			N.A.
	Medium	Partial	None; potentially: ASTM WK62744 SAE AIR5665B ASTM WK62731 SAE ARP5707 NFPA 2400 ASTM WK62741 ASTM F1583	No appropriate standard available yet or available for review	N.A.	
	High				N.A.	

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3.17 *OSO 17* – Remote crew is fit to operate

3.17.1 Requirement Description

Table 288 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1 Effectiveness to fulfil the requirement	Low	The applicant has a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.
	Medium	Same as Low. In addition: • Duty, flight duty and resting times for the remote crew are defined by the applicant and adequate for the operation. • The operator defines requirements appropriate for the remote crew to operate the UAS.
	High	Same as Medium. In addition: • The remote crew is medically fit, • A Fatigue Risk Management. System (FRMS) is in place to manage any escalation in duty/flight duty times.

Table 289 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The policy to define how the remote crew declares themselves fit to operate (before an operation) is documented. The remote crew declaration of fit to operate (before an operation) is based on policy defined by the applicant.

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<table>
<tr><td rowspan="2">Effectiveness to fulfil the requirement</td><td>Medium</td><td>Same as Low. In addition:
• Remote crew duty, flight duty and the resting times policy are documented.
• Remote crew duty cycles are logged and cover at a minimum:
○ when the remote crew member’s duty day commences,
○ when the remote crew members are free from duties, and
○ resting times within the duty cycle.
• There is evidence that the remote crew is fit to operate the UAS.</td></tr>
<tr><td>High</td><td>Same as Medium. In addition:
Medical standards considered adequate by the competent authority and/or means of compliance acceptable to that authority are established and a competent third party verifies that the remote crew is medically fit.
• A competent third party validates the duty/flight duty times.
• If an FRMS is used, it is validated and monitored by a competent third party.</td></tr>
</table>

3.17.2 Summary

Table 290 OSO 17 Standards’ effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1* L	M	H
Integrity					
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	
Assurance					
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P	

3.17.3 Integrity Coverage Detail

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Table 291

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P		Does not seem to address resting times during duty/ flight duty times.

Table 292

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P		This standard provides only high level guidance with no specific definition of what medical fitness means.

3.17.4 Assurance Coverage Detail

Table 293

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

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Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3	P	P		This standard provides only high-level guidance with no specific definition of what medical fitness means.

3.17.5 Gaps

3.17.5.1 Summary

Table 294 Gap Summary - OSO 17

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of criteria to address fit conditions before or during duty times	-10	It is strongly recommended to develop a standard covering not only general fit conditions for operational licenses, but also to determine the particular fit conditions before and during duty times.
2	Lack of standards to define a Fatigue Risk Management System (FRMS)	-8	There is not even a single standard to define a Fatigue Risk Management System. Thus, there is a serious gap in the regulatory framework for safety.

3.17.5.2 Details

Table 295

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	Lack of criteria to address fit conditions before or during duty times	Safety (3)	Very High	Physical and mental condition can greatly affect basic drone operations. Stress and fatigue are highly contributing factors to maintain a satisfactory level in safety.	-2	-6

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1		Cost of compliance to the requirement with a lack standard (2)	High	Without standards providing criteria to address fit conditions, both the integrity of the equipment and the performance of the operation can be jeopardised.	-1	-2
		Environmental Impact (1)	N/A		0	0
		Impact on EU Industry competitiveness (1)	N/A		0	0
		Social Acceptance (1)	Very negative	Working conditions seem to be a sensitive issue for the general public.	-2	-2
Total Weighted Score						**-10**

Table 296

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards to define a Fatigue Risk Management System (FRMS)	Safety (3)	Very High	Depending on the operation, resting might represent and important safety factor.	-2	-6
		Cost of compliance to the requirement with a lack standard (2)	Medium	There is a direct correlation of the cost of compliance to this requirement but the magnitude cannot be assessed.	0	0
		Environmental Impact (1)	N/A		0	0
		Impact on EU Industry competitiveness (1)	N/A		0	0
		Social Acceptance (1)	Very Negative	Enabling drone missions in populated areas can trigger social awareness due to the significant imposed risk.	-2	-2
Total Weighted Score						**-8**

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3.17.6 Conclusions and Recommendations

None of the existent standards were found to fully cover the criterion on its highest robustness level, whereas they can be used separately to identify the individual segments that make up the total requirement. None of these standards was found to define or specify a Fatigue Risk Management System (FRMS).

Crew physical and mental condition is directly related to the safety and performance efficiency of any drone operation. While the general need to address fit requirements for the licencing of the drone operation has been identified within some standards, the gap assessment presents the need to identify and evaluate the same conditions before and during duty times as well as provisions about required intermediate breaks for resting. The effects of fatigue have not been recorded adequately and no remedial instructions are provided through a FRMS.

Table 297 Recommended Standards

Integrity/Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion	Low	Partial	NO STANDARD REQUIRED	The following standard may be used as guidance: ISO 21384-3 UAS – Part 3: Operational Procedures could be used as guidance. However, this standard provides only high-level guidance with no specific definition of what medical fitness means.		
	Medium	Full	NO STANDARD REQUIRED	The following standard may be used as guidance: ISO 21384-3 UAS – Part 3: Operational Procedures could be used as guidance. However, this standard provides only high-level guidance with no specific definition of what medical fitness means.		
	High			NO STANDARD AVAILABLE	N.A.	

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3.18 *OSO 18* – Automatic Protection of the flight envelope from human errors

3.18.1 Requirement Description

Table 298 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion	Low	The UAS flight control system incorporates automatic protection of the flight envelope to prevent the remote pilot from making any single input under normal operating conditions that would cause the UA to exceed its flight envelope or prevent it from recovering in a timely fashion.
	Medium	The UAS flight control system incorporates automatic protection of the flight envelope to ensure the UA remains within the flight envelope or ensures a timely recovery to the designed operational flight envelope following remote pilot error(s).
	High	(The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance.)

Table 299 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion	Low	The automatic protection of the flight envelope has been developed in-house or out of the box (e.g. using Component Off The Shelf elements), without following specific standards.
	Medium	The automatic protection of the flight envelope has been developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	High	Same as Medium. In addition, evidence is validated by EASA.

3.18.2 Summary

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Table 300 OSO 18 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness Criterion 1		
			L	M	H
UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671		P	P
Light Unmanned Aircraft Systems Airworthiness Requirements	NATO	STANAG 4703		P	P
General Requirements of Flight Control System for Civil Small and Light Multirotor UAS	ISO	WD 24355		(P)	(P)
Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	JARUS	CS-LUAS		P	P
Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	JARUS	CS-LURS		P	P

3.18.3 Coverage Detail

Table 301

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671		P	P	The standard covers flight envelope protection in several conditions; however, it does not clearly refer to pilot error(s).

Notes:

1. Published
2. Potential applicable sections for OSO #18:
   - USAR.U334
   - USAR.1329
3. The standard defines a set of technical airworthiness requirements intended primarily for the airworthiness certification of fixed-wing military UAS with a maximum take-off weight between 150 and 20,000 kg that intend to regularly operate in non-segregated airspace

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Table 302

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Light Unmanned Aircraft Systems Airworthiness Requirements	NATO	STANAG 4703		P	P	The standard covers flight envelope protection in several conditions; however, it does not clearly refer to pilot error(s).

Notes:

1. Published
2. Potential applicable sections for OSO #18:
   - UL.58
3. The standard defines a minimum set of technical airworthiness requirements intended for the airworthiness certification of fixed-wing Light UAS with a maximum take-off weight not greater than 150 kg and an impact energy1 greater than 66 J (49 ft-lb) that intend to regularly operate in non-segregated airspace

Table 303

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
General Requirements of Flight Control System for Civil Small and Light Multirotor UAS	ISO	WD 24355		(P)	(P)	The standard is still in planning phase. It cannot be judged since it is not yet available. However, it defends that a standardisation process regarding FCS for UAS should be activated and is, therefore, believed to cover some of the requirements of OSO#18 (Automatic protection of the flight envelope from human errors).

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Notes:
1. Planned
2. The standard cannot be downloaded but the subject can be identified
3. The standard specifies the composition, functional requirements and performance of flight control and navigation system for civil multi-axis UAV piloted aircraft

Table 304

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	JARUS	CS-LURS		P	P	The standard defines minimum design requirements but only for Light Rotorcraft UAS. Moreover the requirements contained in the document might be too demanding for a Low level of robustness.

Notes:
1. The applicable requirement for this OSO could be: CS-LURS.1329 Flight control system
2. The standard is a Certification Specification applicable to Light Unmanned Rotorcraft Systems with Light Unmanned Rotorcraft maximum certified take-off weights not exceeding 750 kg.

Table 305

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	JARUS	CS-LUAS		P	P	The standard defines minimum design requirements but only for Light Aeroplane UAS. Moreover the requirements contained in the document might be too demanding for a Low level of robustness.

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Notes:
1. The applicable requirement for this OSO could be: CS-LUAS.1329 Flight control system and operational flight envelope protection
2. The standard is a Certification Specification applicable to Light Unmanned Aeroplane Systems with Light Unmanned Rotorcraft maximum certified take-off weights not exceeding 750 kg.

3.18.4 Gaps

3.18.4.1 Summary

Table 306 Gap Summary - OSO 18

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.	-2	It is recommended to develop standards covering automatic protection of the flight envelope following remote pilot errors specifically designed for small civil UAS.

3.18.4.2 Details

Table 307

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.	Safety (3)	Low	The absence of standards is very sensitive for safety as these protections might not be correctly implemented resulting in vulnerability in case of remote pilot errors.	+1	+3

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1		Cost of compliance to the requirement with a lack standard (2)	Very High	Operational costs may increase as limitations on the remote pilot actions are set in order to comply with this requirement without a reference standard or following very demanding requirements.	-2	-4
		Environmental Impact (1)	No Impact	-	0	0
		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	People may be concerned about the safety around UAS if they feel that UAVs are unpredictable in terms of flight stability.	-1	-1
Total Weighted Score						**-2**

3.18.5 Conclusions and Recommendations

There are existing standards potentially covering the OSO 18 requirements. However, these standards are not specifically tailored for small civil UAS, with a potential negative impact on the actual capacity of the manufacturers to comply with the at a reasonable cost. EUROCAE WG-105 SG-63 is currently working on standards to cover this OSO which should provide more detailed guidelines. This work will be monitored.

Table 308 Recommended Standards

Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
	Low	N.A.	NO STANDARD REQUIRED			

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Criterion #1	Medium	Partial	STANAG 4671 – UAV System Airworthiness Requirements (USA)	• The standard does not clearly refer to pilot error(s). • Only applicable to fixed-wing military UAV Systems with a maximum take-off weight between 150 and 20,000 kg	1	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.
		Partial	STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements	• The standard does not clearly refer to pilot error(s). • Only applicable to minimum risk operations.	1	
		Partial	JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	• The standard is too demanding for operations until SAIL IV. A guidance is needed to determine which subset of the proposed requirements should be used for medium level of robustness. • Only applicable to Light Unmanned Rotorcraft Systems. Possible applicable requirements: • CS-LURS.1329 Flight control system	1	

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		Partial	JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	• The standard is too demanding for operations until SAIL IV. A guidance is needed to determine which subset of the proposed requirements should be used for medium level of robustness. • Only applicable to Light Unmanned Aeroplane Systems. Possible applicable requirements: • CS-LUAS.1329 Flight control system and operational flight envelope protection	1	
	High	Partial	STANAG 4671 – UAV System Airworthiness Requirements (USA)	• The standard does not clearly refer to pilot error(s). Only applicable to fixed-wing military UAV Systems with a maximum take-off weight between 150 and 20,000 kg	3	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.
		Partial	STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements	• The standard does not clearly refer to pilot error(s). Only applicable to minimum risk operations.	3	
		Partial	JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	• Only applicable to Light Unmanned Rotorcraft Systems. Possible applicable requirements: CS-LURS.1329 Flight control system	3	

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		Partial	JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	• Only applicable to Light Unmanned Aeroplane Systems. Possible applicable requirements: CS-LUAS.1329 Flight control system and operational flight envelope protection	3	

3.19 OSO 19 – Safe Recovery from Human Error

3.18.6 Requirement Description

Table 309 Integrity Requirement Descriptions'

Criterion	Robustness	Description
Criterion #1 (Procedures and checklists)	Low Medium High	Procedures and checklists that mitigate the risk of potential human errors from any person involved with the mission are defined and used. Procedures provide at a minimum: • a clear distribution and assignment of tasks, • an internal checklist to ensure staff are adequately performing assigned tasks.
Criterion #2 (Training)	Low Medium High	The Remote Crew is trained to procedures and checklists. The Remote Crew receives Crew Resource Management (CRM) training.
Criterion #3 (UAS design)	Low	Systems detecting and/or recovering from human errors are developed to industry best practices.
	Medium High	Systems detecting and/or recovering from human errors are developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.

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Table 310 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Procedures and checklists)	Low	Procedures and checklists do not require validation against either a standard or a means of compliance considered adequate by the competent authority. The adequacy of the procedures and checklists is declared.
	Medium	Procedures and checklists are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. Adequacy of the procedures and checklists is proven through: • Dedicated flight tests, or • Simulation provided the simulation is proven valid for the intended purpose with positive results.
	High	Same as Medium. In addition: • Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative. • The procedures, checklists, flight tests and simulations are validated by a competent third party.
Criterion #2 (Training)	Low	Consider the criteria defined for level of assurance of the generic remote crew training OSO (i.e. OSO #09, OSO #15 and OSO #22) corresponding to the SAIL of the operation.
	Medium	
	High	
Criterion #3 (UAS design)	Low	The applicant declares that the required level of integrity has been achieved.
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation, inspection, design review or through operational experience.
	High	EASA validates the claimed level of integrity.

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3.18.7 Summary

Table 311 OSO 19 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*		
			L	M	H	L	M	H	L	M	H
Assurance and Integrity											
Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A.				P	P	P			
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 - 18				(P)	(P)	(P)			
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266-18				P	P				
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP 5707					(P)	(P)			
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	23665				P	P	P			
Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3379-20				(P)	(P)				
Unmanned aircraft systems — Part 3: Operational procedures	ISO	21384-3		P							
Guide for Training and Equipping Visual Observers of Unmanned Aircraft Systems (VO Endorsement)	ASTM	WK62741				(P)	(P)				
Assurance											
Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	JARUS	N.A						F			

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3.18.8 Integrity & Assurance Coverage Detail

Table 312

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A.				P	P	P				The document contains extensive training to remote pilots trained for VLOS and BVLOS operations but does not mention training requirements for other participants (Visual Observer) whose training would be relevant for the safe management of the flight
The document is developed by JARUS ad hoc to comply with the OSOs related to training. Currently it is the unique document providing a training syllabus ad hoc for BVLOS operations.												

Table 313

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330-18				(P)	(P)	(P)				The document is a useful guideline defining the requirements for training and the development of training manuals for a UAS operator, potentially covering UAS up to 600 kg. It does not contain training for other crew member than the pilot.

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Table 314

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266–18				P	P					This standard partially covers the OSO#19 Assurance as required by Assurance Criterion 2 of OSO #9,15,22 and the OSO#19 integrity because it does not include Human Performance training aspects. The evaluated standard does not mention the need for simulations, which are needed to fully satisfy medium robustness. Thus, high robustness is not addressed and the standard satisfies partially low and medium robustness.
This document provides fundamental general knowledge, task performance, activities and functions for remote pilots of lightweight UAS. It can also be used to verify whether other syllabi or courses are complete.												

Table 315

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	

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Standard Title	SDO	Doc. Reference	Robustness Criterion 1 L	Robustness Criterion 1 M	Robustness Criterion 1 H	Robustness Criterion 2 L	Robustness Criterion 2 M	Robustness Criterion 2 H	Robustness Criterion 3 L	Robustness Criterion 3 M	Robustness Criterion 3 H	Gaps
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP 5707					(P)	(P)				This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) for use by operators, manufacturers, and regulators. The identification of training topics is based initially on Practical Test Standard (PTS) topics for manned aircraft pilots. Because of this, the standard is deemed too complex for low robustness operations.
Note: Due to the unavailability of this document, the assessment has been done only by the chapter outlines.												

Table 316

Standard Title	SDO	Doc. Reference	Robustness Criterion 1			Robustness Criterion 2			Robustness Criterion 3			Gaps
			L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	23665				P	P	P				This standard fulfils completely the OSO #9,15,22 as required by Assurance Criterion 2 and by OSO#19 Criterion 2 integrity. However, it only mentions that the crewmates/ colleagues must be told what their duties are and must demonstrate them, without mentioning what those tasks are. The standard also mentions specific VLOS practical training but does not include BVLOS training requirements or other specific requirements.
This document is currently in External consultation phase, once published and/or recognized, its ranking will improve as well.												

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Table 317

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3379-20				(P)	(P)					This guide covers the minimum training requirements for public safety remote pilots (PS-RPs) as it relates to their general, field, and search specific knowledge and skills. This guide by itself is not a training document and should be used in conjunction with other applicable guides (e.g. F3330 or F3266). It does not cover specific operations (such as in caves, semi-collapsed buildings etc) or other context-related training.
Note: this standard only addresses Public Safety remote Pilots, i.e. pilots operating UAS for local or national organizations (firemen, ambulance, police etc)												

Table 318

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	

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Unmanned aircraft systems — Part 3: Operational procedures	ISO	21384-3		P								Section 10 of the standards provides an extensive list of elements to be covered by appropriate procedures and checklists during preparation, execution and termination of operations. Nevertheless, no standards nor best practice about the definition of such procedures and checklist are defined. A clear distribution and assignment of tasks is not provided, yet the roles and competencies of the entire remote crew (other than rPIC) are just listed.

Table 319

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	

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Guide for Training and Equipping Visual Observers of Unmanned Aircraft Systems (VO Endorsement)	ASTM	WK62741					(P)					Currently the only document directly referring to the Visual Observer (VO), its role, training and communication with the rest of the crew / the remote pilot. This standard focuses on the VO that operate on the surface of the land only, including urban or disaster areas that may be isolated or have lost supporting infrastructure. It only partially covers OSO#19 because personnel trained to this guide should follow also other training programs (ie. as defined by Specification F3330) and further training may be required before visual observer endorsed personnel may participate on a particular UAS mission. This guide alone does not provide the minimum training requirements for UAS VO personnel performing specific operations and considers only generic UAS systems and gears.
Note: Currently this document is a working draft.												

Table 320

3.18.9 Assurance Coverage detail

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	

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Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	JARUS	N.A.						F				This document provides guidance material (GM) on the qualification for an entity that a competent authority may recognise as a provider for theoretical knowledge examination and practical skill assessment. This recognised assessment entity (RAE) can be any natural or legal person (e.g. training organisation, educational institution or UAS operator) as deemed acceptable by the competent authority.
The document is developed by JARUS to complement JARUS guidelines on Remote Pilot Competencies. It represents an AMC to comply with high level of assurance as it defines requirements for a Recognized Assessment Entity.												

3.18.10 Gaps

3.18.10.1 Summary

Table 321 Gap Summary - OSO 19

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of specific standards for procedures able to provide at a minimum: • a clear distribution and assignment of tasks, • an internal checklist to ensure staff are adequately performing assigned tasks.	-4	It is recommended to fully develop a standard covering procedures and checklist for error recovery including a clear allocation of tasks among the remote crew.

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2	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight.	-5	It is strongly recommended to fully develop a standard covering training for visual observers, mainly for safety reasons.
3	Lack of standards addressing systems to detect and/or recover from human errors.	-4	It is recommended to develop best practices (for low robustness) and/or standards (for medium/high robustness) to address the design of systems to detect and/or recover from human errors (Criterion #3).

3.18.10.2 Details

Table 322

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of specific standards for procedures able to provide at a minimum: a clear distribution and assignment of tasks and internal checklist to ensure staff are adequately performing assigned tasks.	Safety (3)	High	Adequate procedures and related checklist for tasks allocation within the remote crew are crucial elements to support UAS operations' safety by reducing the likelihood and effects of human errors.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	The ISO 21384-3 contains an extensive list of procedures and checklists but no details on how they were designed. Thus, it is time consuming for oversight authorities to check the adequacy of procedures and checklists.	0	0
		Environmental Impact (1)	Not applicable		0	0
		Impact on EU Industry competitiveness (1)	No impact	The existence of only one ISO standard partially covering this OSO does not have immediate impact on industry competitiveness.	0	0

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		Social Acceptance (1)	Negative	Having clear standardised procedures and checklists would have a positive impact on public perception of drone operations safety.	-1	-1
Total Weighted Score						**-4**

Table 323

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	Safety (3)	High	In some UAS operations there might be personnel, other than remote pilot, who is responsible for the safe management of the flight and error recovery. For instance, visual observers are key elements for BVLOS operations. Their role is to support the RPIC in the flight management, especially to remark presence of other hazards (e.g. other traffic, obstacles etc) when the drone is not in the LOS of the remote pilot.[7] Currently a only a working draft exists WK62741 that covers the training for Visual Observers in generic situations.	-1	-3

[7] EU regulation 947/2019 establishes that visual observers "*assist the remote pilot in safely conducting the flight. Clear and effective communication shall be established between the pilot and the observer*".

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		Cost of compliance to the requirement with a lack standard (2)	Medium	The lack of standards makes more difficult and time consuming for training organisations and operators to develop a training programme[8]. At the same time, it is time consuming for oversight authorities to check skills and competencies.	0	0
		Environmental Impact (1)	Not applicable		0	0
		Impact on EU Industry competitiveness (1)	Negative	The adoption of standards could foster the demand for training organisations to deliver ad hoc courses.	-1	-1
		Social Acceptance (1)	Negative	As the role of the observers is important in certain phases of the flight, people may be concerned about the fact that there are no specific training requirements, especially for flights in urban environment. However there is a working draft ASTM WK62741 which will cover this gap in the future.	-1	-1
Total Weighted Score						**-5**

Table 324

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	Lack of standards addressing systems to	Safety (3)	High	High tier operations of medium/high robustness (SAIL IV+) may require systems to detect and/or recover from human errors to be developed to industry recognised standards. The safe design of	-1	-3

[8] EU Regulation 947/2019 establishes that "*personnel in charge of duties essential to the UAS operation, other than remote pilot itself, have completed the on-the-job training developed by the operator*".

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	detect and/or recover from human errors.			these systems is a crucial element to support UAS operations by reducing the likelihood and effects of human errors.		
		Cost of compliance to the requirement with a lack standard (2)	Medium	Low tier operations may find compliance to a demanding design criterion too demanding. Conversely, higher tier operations would require compliance to the criterion, so the absence of such a standard/best practice would result too time consuming.	0	0
		Environmental Impact (1)	Not applicable		0	0
		Impact on EU Industry competitiveness (1)	No impact	No impact on EU industry competitiveness identified.	0	0
		Social Acceptance (1)	Negative	The absence of (design) best practices ultimately aimed at avoiding human error may be seen negatively.	-1	-1
Total Weighted Score						**-4**

3.18.11 Conclusions and Recommendations

For OSO 19 Safe recovery from Human Error, most standards applicable are related to Criterion #1 Procedures and checklists and Criterion #2 training. As such, standards are considered both for Integrity, because they contain the actual items that must be checked or trained for and for whom they apply (Pilot in Command, Remote Pilot in Command, Visual Observer or Crew) and at the same time, the standards can be used for assurance to verify other standards' completeness. Where assurance implies other activities, such as simulations or training flights, their absence (if applicable) is explicitly mentioned. Therefore, most standards are considered both for integrity and assurance for OSO 19.

OSO #19 seems to be partially covered for Criterion 1 and 2, Low, Medium and High Robustness Integrity. Criterion 2 (Training) can potentially by fully covered in the future with the development of the training material for Visual Observers, as mentioned in ASTM WK62741. This standard, combined with JARUS Recommendation for RPC have the potential to cover fully all training requirements in the future, including those for safe recovery from Human Error. For Criterion 1 (Checklists and Procedures), ISO 21384-3 covers provides only a high-level outline of the procedures and checklists and it or another standard should be detailed more to fully comply with the SORA requirements. To the best of our knowledge, no standard covering Criterion 3 (Design) currently exists. Standards for Systems detecting and/or recovering from human errors do not exist, the closest possible approach is through a good HMI, covered by OSO #20.

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Table 325 Recommended Standards – Integrity & Assurance

Integrity & Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Procedures and checklists)	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3 UAS – Part 3: Operational Procedures	It only provides high level guidance with no specification on how to practically develop the required procedures to fulfil this OSO.	2	Lack of specific standards for procedures able to provide at a minimum: - a clear distribution and assignment of tasks, - an internal checklist to ensure staff are adequately performing assigned tasks.
	High		ISO 21384-3 UAS – Part 3: Operational Procedures	It only provides high level guidance with no specification on how to practically develop the required procedures to fulfil this OSO.	4	A clear distribution and assignment of tasks is not provided, and the roles and competencies of the entire remote crew (other than rPIC) are just listed.
Criterion #2 (Training)	Low (integrity only)	Partial	JARUS Recommendations for RPC	Covers in detail VLOS and BVLOS requirements, while It only includes training requirements for the Remote Pilot.	7	JARUS recommendation for RPC and ASTM WK62741 could potentially cover all aspects related to training to improve recovery following a human error, both for the Pilot in Command and the Visual Observer. However ASTM WK62741 is potentially too strict for Low tier operations.

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			ASTM F3266-18	Covers training for the PIC only.	4	Lacks training for other remote crew and misses human Performance aspects.
			ASTM F3379-20	Covers basic training for Public Safety Remote Pilots but would need to comply with other docs such as F3330 or JARUS Recommendation to be able to operate UAS. Most likely such standard will have low use for low robustness since most PS operations are of medium or high robustness.	4	
			ASTM F3330 – 18		2	Lacks HP considerations and training for other remote crew
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors. This standard is in the publication process.	0	Covers training for the PIC yet lacks BVLOS considerations.
	Medium (Integrity and Assurance)		JARUS Recommendations for RPC	Covers in detail VLOS and BVLOS requirements, while It only includes training requirements for the Remote Pilot.	7	JARUS recommendation for RPC and ASTM WK62741 could potentially cover all aspects related to training to improve recovery following a human error, both for the Pilot in Command and the Visual Observer. However ASTM WK62741 is potentially too strict for Low tier operations.
			ASTM F3266-18	Covers training for the PIC only.	6	Lacks training for other remote crew and misses human Performance aspects.

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			ASTM F3379-20	Covers basic training for Public Safety Remote Pilots but would need to comply with other docs such as F3330 or JARUS Recommendation to be able to operate UAS. Most likely such standard will have low use for low robustness since most PS operations are of medium or high robustness.	4	
			ASTM F3330 – 18		4	Lacks and training for other remote crew
			ARP5707	This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) from manned aviation concepts. Assessed from the outline.	4	
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors.	2	Covers training for the PIC, yet lacks BVLOS considerations.
			ASTM WK62741	The only document specifically geared towards Visual observers. Assessed from the abstract only.	0	Lacks training for the PIC.
	High (Integrity and Assurance)		JARUS Recommendations for RPC	Covers in detail VLOS and BVLOS requirements, while It only includes training requirements for the Remote Pilot.	7	JARUS recommendation for RPC and ASTM WK62741 could potentially cover all aspects related to training to improve recovery following a human error, both for the Pilot in Command and the Visual Observer.

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			ARP5707	This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) from manned aviation concepts. Assessed from the outline.	6	
			ASTM F3330 – 18		6	Lacks and training for other remote crew
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors.	4	Covers training for the PIC yet lacks BVLOS considerations.
			ASTM WK62741	The only document specifically geared towards Visual observers. Assessed from the abstract only.	2	Lacks training for the PIC.
Criterion #3 (UAS design)	Low	N.A.		NO STANDARD AVAILABLE	N.A.	Lack of best practices/standards addressing the design of systems to detect and/or recover from human errors.
	Medium	N.A.		NO STANDARD AVAILABLE	N.A.	
	High	N.A.		NO STANDARD AVAILABLE	N.A.	

Table 326 Recommended Standards -Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #2	Low	Covered in Table 325 above, together with Integrity as described in the conclusions.				
	Medium					

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(Training)	High	Full	Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	For high robustness assurance, the JARUS GM covers fully how a RAE is defined and what are its tasks in relation to the entities it audits.	12	

3.19 OSO 20 – A Human Factors evaluation has been […] found appropriate for the mission

3.19.1 Requirement Description

Table 327 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation.
	Medium	
	High	

Table 328 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The applicant conducts a human factors evaluation of the UAS to determine if the HMI is appropriate for the mission. The HMI evaluation is based on inspection or Analyses.
	Medium	Same as Low but the HMI evaluation is based on demonstrations or simulations.

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	High	Same as Medium. In addition, EASA witnesses the HMI evaluation of the UAS and a competent third party witnesses the HMI evaluation of the possible electronic means used by the VO.

3.19.2 Summary

Table 329 OSO 20 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*		
			L	M	H
Integrity					
UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671	P	P	P
Light Unmanned Aircraft Systems Airworthiness Requirements	NATO	STANAG 4703	P	P	P
Assurance					
SESAR Human Performance Assessment	SESAR PJ19	N.A.	P	P	P

3.19.1 Integrity Coverage Detail

Table 330

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

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UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671	P	P	P	In principle, STANAG 4761 covers the OSO #20 requirements up to SAIL VI for integrity. Nonetheless, its approach is systems oriented (navigation, powerplant parameters…) and furthermore mainly focus on ergonomics and anthropometrics. However, most of the human performance issues observed with modern systems and HMIs are related to cognitive ergonomics and usability matters.
No "holistic approach". Systems oriented (navigation, powerplant parameters…) and mainly focus on ergonomics and anthropometrics. Low focus on cognitive functions Too much complex and expensive for low complexity applications.						

Table 331

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Light Unmanned Aircraft Systems Airworthiness Requirements	NATO	STANAG 4703	P	P	P	HMI aspects like layout of the controls is only high level. Not aimed at rotary UAS. In addition to the limitations highlighted for STANAG 4671, several areas of human factors challenges seem not covered by the STANAG 4703: - Unconventional characteristics of unmanned - Reliance on automation - Reduced sensory cues
Covers information needed for the safe conduct of flight and information concerning unsafe conditions.						

3.19.2 Assurance Coverage Detail

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Table 332

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
SESAR Human Performance Assessment	SESAR PJ19	N.A.	P	P	P	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission. The SESAR HPA process is a good starting point for the identification of appropriate HP arguments, but it is thought for ATM concepts validation. Specific UAS issues are not covered.
HPA is a guidance methodology to evaluate the human performance impact of new operational concepts; while aimed at manned aviation, the HPA covers the necessary points for standard operations: • 2.2.1 the accuracy of information provided by the system is adequate for carrying out the task; • 2.2.2 the timeliness of information provided by the system is adequate for carrying out the task; • 2.3 (and sub-arguments) the design of the human-machine interface supports the human in carrying out their tasks. The process includes Evidence (Success Criteria) for inspections, Analyses, Demonstrations and Simulations. Nevertheless, being HPA thought to cover manned aviation concepts, it may be difficult to deeply analyse some issues specific to drones using such methodology (e.g. VLOS, E-VLOS).						

3.19.3 Gaps

3.19.3.1 Summary

Table 333 Gap Summary - OSO 20

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation

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1	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	-4	The assessment shows that there is the urgency to develop standards to cover this gap. Work is on-going at EUROCAE level as WG 105/ SG 61 should publish in the future standards related to Applicability of Safe Design Standard for UAS in Specific Operations Category that will address, among the others, HMI design standards.
2	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission.	-5	The assessment shows that there is the urgency to develop standards to cover this gap. The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, being HPA thought to cover manned aviation concepts, it may be difficult to deeply analyse some issues specific to drones using such methodology. Specific considerations on human factors for UAS are collected in the "Human Factors Guidelines for Unmanned Aircraft System Ground Control Stations" published by the NASA within the *UAS in the NAS* Project and might be considered when developing UAS-specific versions of human factors evaluation methodologies to cover the identified gap.

3.19.3.2 Details

Table 334

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	Safety (3)	Medium	An adequate HMI is a crucial element to support UAS operations safety by reducing the likelihood and effects of human errors. In absence of a defined standard for UAS HMI design and development, it is hard for operators to understand to what extent the available HMI is able to safely support their missions in terms of information presentation, human error, fatigue.	0	0
		Cost of compliance to the requirement with a lack standard (2)	Medium	In the presence of only information/guidance material, human factors considerations in the design and development of the HMI (e.g. information presentation, human error, crew fatigue) may vary slightly from a manufacturer to another, with consequent costs for	-1	-2

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				the operators to adapt their operation manuals to the different interfaces. On the other hand, it will be more time consuming for Authorities to verify adequacy of HMI design and development. The absence of a standard HMI development philosophies may also lead to increased training costs for pilots and crews.		
		Environmental Impact (1)	Neutral	An information/guidance doc to define adequate design and development guidelines for the HMI of drones, enables more efficient and safer operation compared to when such standard is completely absent, thus leading to environmental benefits.	0	0
		Impact on EU Industry competitiveness (1)	Negative	The available guidance, based on a military standard could potentially prove too restrictive for low and possibly medium robustness operations and could possibly hinder EU competitiveness.	-1	-1
		Social Acceptance (1)	Negative	Having a clear framework for the design and development of drones HMI (including automated safety features) would have a positive impact on public perception of drone operations safety.	-1	-1
Total Weighted Score						**-4**

Table 335

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission.	Safety (3)	Low	An adequate HMI is a crucial element to support UAS operations safety by reducing the likelihood and effects of human errors. In absence of a defined standard for UAS HMI human factors evaluation, it is hard for operators to understand to what extent the available HMI is able to safely support their missions.	-1	-3

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		Cost of compliance to the requirement with a lack standard (2)	Medium	In absence of standards, it takes longer for operators to understand whether the HMI performance is adequate for the operations. On the other hand, it will be more time consuming for Authorities to verify adequacy of HMI human factors evaluation. The absence of a standard human factors evaluation of HMI may also lead to increased training costs for pilots and crews.	-1	-2
		Environmental Impact (1)	No impact	A standard to define adequate means of human factors evaluation for the HMI of drones would enable more efficient and safer operation, thus leading to environmental benefits.	0	0
		Impact on EU Industry competitiveness (1)	Positive	The Human Performance Assessment Procedure has been developed in the SESAR framework, thus making it easier for EU based SMEs to adopt it (or a variant of it).	1	1
		Social Acceptance (1)	No impact	Having a clear framework for the evaluation and assessment of Human Factors issues of drones HMI (including automated safety features) would have a positive impact on public perception of drone operations safety.	-1	-1
Total Weighted Score						**-5**

3.19.4 Conclusions and Recommendations

Table 336 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**

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Criterion #1	Low	Partial	STANAG 4671	No "holistic approach". Systems oriented (navigation, powerplant parameters…) and mainly focus on ergonomics and anthropometrics. Low focus on cognitive functions. For fixed wing only. Too much complex and expensive for low complexity applications.	1	
		Partial	STANAG 4703	STANAG 4703 covers the HMI aspects that must be designed to facilitate the safe accomplishment of the design missions in a more high-level approach (information layout, to the information readability in all external lighting conditions, to aural signals etc). Potentially too restrictive for low robustness. For fixed wing only.	1	
	Medium	Partial	STANAG 4671	Same as for Low. Maybe expensive for medium complexity applications.	3	
		Partial	STANAG 4703	Same as for Low. Maybe expensive for medium complexity applications.	3	Covers high level aspects for control layout. For fixed wing only.
	High	Partial	STANAG 4671	Same as for Low. Not expensive for high complexity applications.	5	
		Partial	STANAG 4703	Same as for Low. Not expensive for high complexity applications.	5	Covers high level aspects for control layout

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Table 337 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Partial	SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	2	Not directly developed for UAS and might be difficult to directly asses UAS-related aspects
	Medium	Partial	SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	4	Not directly developed for UAS and might be difficult to directly asses UAS-related aspects

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	High	Partial	SESAR Human Performance Assessment (HPA) SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	4	Not directly developed for UAS, and does not mention the 3rd party to assess the VO HMI, in addition to the competent authority that verifies the HF and HMI considerations for the PIC.

OSO 20 Integrity is covered partially by a STANAG 4671. During the second workshop with EASA, EASA experts presented their review of the NASA document "Human factors guidelines for unmanned aircraft systems" (Hobbs & Lyall, 2016) and "FMS for unmanned aerial systems: HMI issues and new interface solutions" (Damilano, Guglieri, Quagliotti, & Sale, 2012). The revision led to build a table of human factors challenges for UAS. Each challenge has been linked with the STANAG 4671 requirements to assess whether this standard allows to tackle the main HF challenges brought by UAS. Refer to the table below.

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Elements that may induce human factors challenges	Description of the human factor challenge	STANAG 4671 requirements that should cover the HF challenge
Reduced sensory cues	The pilot of an unmanned aircraft has no out-the-window view to assist with navigation, collision avoidance, or weather awareness. The absence of auditory, proprioceptive, and olfactory sensations may also make it more difficult to monitor the state of the aircraft and reduce situational awareness. Onboard cameras, where available, typically present the pilot with a monocular image covering a restricted field of view.	USAR.1704 Minimum UAS crew USAR.U1787 UAS automatic diagnostic and monitoring USAR.U1788 Degraded modes of operation warning USAR.U1827 Flightpath deviation warning USAR.U1829 UAS safety status indication
Control and communication via radio link	The UAS pilot must monitor and anticipate the quality of the control link and be prepared for link interruptions. Link latencies may make direct manual control difficult and may disrupt voice communications when these are relayed via the radio link.	USAR.U1611 Command and control data link latency USAR.U1607 Command and control data link performance and monitoring(e) USAR.U1613 Command and control data link loss strategy (c) USAR.U1728 Data link data display, warnings and indicators
Physical characteristics of the control station	Control stations increasingly resemble control rooms or office workstations more than a traditional cockpit. The relative spaciousness of many control stations enables additional information displays to be added easily and without the forethought that would be needed to add them to a cockpit. It may be difficult to enforce sterile cockpit procedures if the control station is housed in an office environment.	USAR.U1703 UAS crew workplace USAR.1704 Minimum UAS crew USAR.U1705 UAS crew work place lights USAR.U1721 Arrangement and visibility USAR.U1727 Electronic data display (a) USAR.U1728 Data link data display, warnings and indicators USAR.U1731 General USAR.U1732 Safety critical controls USAR.U1733 Conventional controls and indicators USAR.U1741 UCS flight controls USAR.U1785 Warning, caution and advisory information colour code USAR.U1787 UAS automatic diagnostic and monitoring USAR.U1788 Degraded modes of operation warning USAR.U1790 UAS mode of control indicator
Transfer of control during ongoing operations	Control of an unmanned aircraft may be transferred during ongoing operations between adjacent control consoles within a control station or between geographically separated control stations. Each transfer may involve a risk of mode errors, inconsistencies between control settings, or miscommunication.	USAR.U1707 Communication system USAR.U1881 UA handover between two UCS(a)(b)(e) USAR.U1883 Command and control of multiple UA USAR.U1885 UA handover within the same UAS control station(a)(b)(e) USAR.U1887 Multiple UA monitoring
Unconventional characteristics of unmanned	Ultra-long-endurance flights may be monotonous and aircraft fatiguing, and a single flight may require multiple transfers of control at crew shift changes. Loitering flight patterns and slow rates of climb and descent may present challenges for air traffic controllers. The pilot may be required to interact with systems not typical of manned aviation, such as electric propulsion, fuel cells, and catapult launch systems.	USAR.1704 Minimum UAS crew
Flight termination	We assume that a UAS will not be used to carry passengers. Therefore in an emergency, the UAS pilot may choose to destroy the aircraft by ditching or other means rather than attempt a landing that could present a risk to people or property on the ground.	USAR.U1412 Emergency recovery capability USAR.U1732 Safety critical controls
Different functions allocation between user and automation	The pilot of a conventional transport aircraft will generally have the ability to turn off or minimize the use of automated systems and transition to manual control of the aircraft, even if this is accomplished via fly-by-wire systems. A single UA can be able to operate with different level of automation, for example switching between manual, semiautomatic and full automatic modes. This fact increases the importance of a correct human–automation interaction, therefore HMI design shall consider the relative problems.	USAR.U1490 Automatic take-off system, automatic landing system(d) USAR.U1492 Manual abort function(a) USAR.U1494 Automatic taxi system(b) USAR.U1769 "Abort" control for automatic take-off system or automatic landing system
Widespread use of interfaces based on consumer products	Current control stations increasingly resemble office workstations, with keyboard, mouse, or trackball interface device, and interfaces operating on consumer computer software. Some control stations are housed entirely on a laptop computer. A control station that contains controls and displays sourced from diverse commercial off-the-shelf providers is likely to suffer from a lack of consistency and other integration issues.	USAR.1704 Minimum UAS crew USAR.U1721 Arrangement and visibility

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Functionally wise, and aside of the "unconventional characteristics of unmanned", it seems therefore that STANAG 4671 has intended to cover all the human factors challenges brought UAS. However, three major areas of improvement are required:

- Area of improvement 1: Although presenting some requirements linked to flight crew interface (refer to the list analysed above), STANAG 4671 is not considered, as currently written, to sufficiently address human factors in a holistic approach. The current approach of STANAG 4671 is system oriented (navigation, powerplant parameters…) and furthermore mainly focus on ergonomics and anthropometrics. However, most of the human performance issues observed with modern systems and HMIs are related to cognitive ergonomics and usability matters.
- Area of improvement 2: The STANAG 4671 only covers the minimization of UA operator error (refer for instance to USAR.U1490(d)) but not the fact that the design should support the recovery following an error. Indeed, since UA operator error will occur, even with a well-trained and proficient UA operator operating well-designed UAS, the design must support the management of those errors to avoid any safety consequences. This deficiency shows therefore that OSO18 cannot thoroughly complied with by means of this standard.
- Area of improvement 3: The AMC associated to the functional requirements listed above are very limited or sometimes not existent (i.e.: USAR.U1703 UAS crew workplace). Besides, there is no AMC that is explaining the human factors process that should be followed thus letting too much variability in the industry practices. This deficiency reveals that OSO20 cannot be thoroughly fulfilled with this standard

Same considerations apply also to STANAG 4703, in addition several areas of human factors challenges seem not covered by the STANAG AEP83:
- Unconventional characteristics of unmanned
- Reliance on automation
- Reduced sensory cues.

OSO 20 Assurance is neither fully covered. The only partial cover is given by the HPA procedure, which can provide a good basis for the development of Assurance methods for HMI and HF. A potential standard that could cover this gap in the future is JAUS AS6040A HMI Service Set, which is currently under development and could not be assessed.

3.20 *OSO 23* – Environmental conditions for safe operations defined […] and adhered to

3.20.1 Requirement Description

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Table 338 Requirements' Description

Integrity Criterion	Robustness	Assurance description
Criterion #1 Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document	Low	The applicant declares that the required level of integrity has been achieved.
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation, inspection, design review or through operational experience.
	High	EASA validates the claimed level of integrity.
Criterion #2 Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple recording system	Low	• Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. The adequacy of the procedures and checklists is declared.

	Medium	• Procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
		• The adequacy of the procedures is proved through:
		  ○ Dedicated flight tests, or
		  ○ Simulation provided the simulation is proven valid for the intended purpose with positive results.

	High	Same as Medium. In addition: • Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. • The procedures, flight tests and simulations are validated by a competent third party.
Criterion #3	Low	Training is self-declared (with evidence available).

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Training covers assessment of meteorological conditions	Medium	• Training syllabus is available. • The operator provides competency-based, theoretical and practical training.
	High	A competent third party: • Validates the training syllabus. • Verifies the remote crew competencies.

3.20.2 Summary

Table 339 OSO 23 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*		
			L	M	H	L	M	H	L	M	H
Integrity/Assurance											
Manual on Remotely Piloted Aircraft Systems (PSURs)	ICAO	DOC 1009								P	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18								(P)	
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	23665								P	P
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3					P				
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707								P	P
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266-18								P	
Assurance											
Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A								F	

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Table 340 OSO 23 Documents not available or under development

Standard Title	SDO	Doc. Reference	Notes
Cockpit Display of Data Linked Weather Information	SAE	ARP5740	ARP5740 is not currently available. Based on scope, the standard covers the information content for the electronic presentation of data linked weather Meteorological (MET) information

3.20.3 Integrity Coverage Detail

Table 341

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Manual on Remotely Piloted Aircraft Systems (PSURs)	ICAO	DOC 1009								P		

Notes: DOC 1009 This document covers environmental considerations about hazardous situations such as icing or cumulonimbus, surface visibility, wind direction / speed and upper air temperature. It covers thus partially as the list of meteorological aspects is not exhaustive and not so detailed.

Table 342

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*	Robustness *Criterion 2*	Robustness *Criterion 3*	Gaps

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			L	M	H	L	M	H	L	M	H	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18								(P)		

Notes: The standard should cover criterion 3 since it states that it "supports professional entities that will receive operator certification by a CAA, and provide standards of practice for self- or third-party audit of operators of UAS". Further scoring could not be provided based on assumptions.

Table 343

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Training for personnel involved in UAS operations	ISO	23665								P	P	The document is limited to remote pilots trained for VLOS operations. Remote pilots involved in BVLOS operation are not covered. Other training aspects for personnel involved in UAS operations not covered.

Notes: ISO 23665 is one of the few documents that provide some further details regarding meteorology and what the training syllabus on this subject should be for UAS operators

Table 344

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	

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Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	JARUS	N.A								F		
Notes: This document is one of the few that provide some specific details regarding what the training syllabus should be for meteorology for UAS operators.												

Table 345

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3					P					The document contains generic procedures that are applicable to any UAS for any specific purpose.

Table 346

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266-18								P		The document covers mainly VLOS operations. It does not specify who will evaluate the syllabus of the training course
Notes: This document contains standard specifications for educators who wish to develop curricula and training courses and individual pilots wishing to raise their knowledge level for particular flight operations												

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Table 347

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707								P	P	The document simply provides an outline for the inclusion of meteorology in the training syllabus of UAS practical tests.
Notes: This document contains standard specifications for the development of training topics for UAS operators, manufacturers, and regulators												

3.20.4 Gaps

3.20.4.1 Summary

Table 348 Gap Summary - OSO 23

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	There are no standards/guidelines to define how to determine adequate environmental/ meteorological conditions for safe operations.	-5	Safe environmental operating conditions should be clearly defined in standards or manuals or any other relevant document to avoid accidents
2	Available standards for the development of procedures are quite generic and do not provide sufficient guidance.	+2	The development of a specific standard does not seem to be necessary at this stage.
3	No current standard completely covers third-party competence for checking environmental/meteorological conditions for both syllabus and skills.	+2	Safe environmental/meteorological conditions should be outlined in standards although third party checking by appropriate authorities could be simply mentioned

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3.20.4.2 Details

Table 349

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	There are no standards/guidelines to define how to determine adequate environmental conditions for safe operations.	Safety (3)	High	In case that drone safe environmental operating conditions are not properly defined there is a high risk of misuse of the equipment in non-safe conditions.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of compliance with defining safe conditions for operations should not be high since it is part of the testing and operators with a licence are already aware under what conditions they should fly a drone	+1	+2
		Environmental Impact (1)	Bad	Not properly defined safe operating conditions of drones could have adverse effect to the environment only in extreme cases in case of accidents that can cause environmental pollution	-2	-2
		Impact on EU Industry competitiveness (1)	Negative	The lack of clearly defined operating safe conditions by manufacturers could affect number of accidents and thus the reputation of EU made drones	-1	-1
		Social Acceptance (1)	Negative	Clearly defined operating safe conditions by manufacturers could affect the general social acceptance due to lack of misuse of drones	-1	-1
Total Weighted Score						**-5**

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Table 350

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Available standards for the development of procedures are quite generic and do not provide sufficient guidance.	Safety (3)	Medium	A competent operator should be able to define adequate procedure also in absence of a specific guideline.	0	0
		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of developing specific procedures should not be high, as this is expected to be standard practice anyways.	+1	+2
		Environmental Impact (1)	Neutral	No environmental impact	0	0
		Impact on EU Industry competitiveness (1)	No impact	No impact	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						+2

Table 351

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	No current standard completely covers third-party competence for checking environmental/meteorological conditions for both syllabus and skills.	Safety (3)	Medium	Training schools will teach anyway meteorology and safe environmental conditions whether they are outlined or not in a standard	0	0

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		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of a third party to check whether the training syllabus or the UAS operator is competent in safe environmental conditions is carried out at a local level anyway	+1	+2
		Environmental Impact (1)	Neutral	No environmental impact	0	0
		Impact on EU Industry competitiveness (1)	No impact	No impact	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**+2**

3.20.5 Conclusions and Recommendations

The assessment of OSO #23- "Environmental conditions for safe operations defined, measurable and adhered to" at this stage can provide some conclusions. Given the context of OSO #23 the standards that are applicable and tend to have a wider coverage are more related to training and competence of pilots rather than other technical standards. Although they do indicate from their assessment that they have a coverage of OSO 23, many standards do not fully cover the requirements..

Table 352 Recommended Standards – Integrity/Assurance

Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 – [Definition]	Low	N.A.	NO STANDARD REQUIRED			There are no standards/guidelines to define how to determine adequate
	Medium			NO STANDARD AVAILABLE	N.A.	

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	High			NO STANDARD AVAILABLE	N.A.	environmental conditions for safe operations.
Criterion #2 [Procedures]	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures	Generic standard which implies that the operator must operate under manufacturer-imposed weather limitations	2	Available standards for the development of procedures are quite generic and do not provide sufficient guidance.
	High			NO STANDARD AVAILABLE	N.A.	
Criterion #3 [Training]	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Full (Assurance)	Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)	This doc covers fully the environmental situations that must be included in training manuals.	13	
		Partial	DOC - 1009 - Manual on Remotely Piloted Aircraft Systems (PSURs)	This document contains safety consideration for the operation of UAS.	7	Provides only high level guidance and environmental aspects dealt with are not exhaustive.
			F3330 – 18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	Generic standard which implies that the operator must operate under manufacturer-imposed weather limitations.	6	High level and does not satisfy any assurance regarding the checks of 3rd party.
			ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	States that the training syllabus for UAS operators should include the knowledge of making local weather assessments	2	Too high level and generic

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			ARP 5707	The document covers partially the medium level of robustness of Criterion #3 (training) by providing a guideline of what the syllabus for training UAS pilots should be. It covers meteorology and also flying with instrument flight rules covering also meteorology in this topic	4	Since it has been assessed from the outline, the coverage is partial but it has the potential to have full coverage.
	High	Partial	ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	ISO 23665 is the only standard that states that the training syllabus must be evaluated.	4	No current standard completely covers third party checking for competence of environmental/ meteorological conditions for both syllabus and skills
			ARP5707	The document covers partially the medium level of robustness of Criterion #3 (training) by providing a guideline of what the syllabus for training UAS pilots should be. It covers meteorology and also flying with instrument flight rules covering also meteorology in this topic	4	Not mentioned that a competent 3rd party must validate the training.

Criterion #1 (Definition) from OSO 23 is not at all covered directly by any standard, possibly because the definition of potentially dangerous environmental conditions is subjective and criterion #3 (Training) covers indirectly such definitions. For Criterion #2 (Procedures), only one standard covers partially procedures for evaluating safe meteorological procedures which are rather important. The absence of such environmental-related checklists represents a significant gap which should be covered in the near future. Criterion #3 (Training) is fully covered on the assurance side by JARUS Recommendation for RPC which mentions the meteorological situations that must be covered by training, but the actual details on how to recognize the dangers of such situations are missing (Integrity). Therefore, standards should identify the syllabus and the appropriate training that the UAS operators should undergo for assessing meteorological conditions.

3.21 *OSO 24* – UAS designed and qualified for adverse environmental conditions

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3.21.1 Requirement Description

Table 353 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	N/A
	Medium	The UAS is designed to limit the effect of environmental conditions.
	High	The UAS is designed using environmental standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. *National Aviation Authorities (NAAs) may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.*

Table 354 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	N/A
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience. *2 When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*
	High	EASA validates the claimed level of integrity.

3.21.2 Summary

Table 355 OSO 24 Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*

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			L	M	H
Integrity/Assurance					
Unmanned Aircraft Systems (UAS) - Product requirements	ASD-STAN	EN4709-001		F	P
UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671		P	P
Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)	NATO	STANAG 4702		P	P
Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)	NATO	STANAG 4703		P	P
Standard for Unmanned Aircraft Systems	UL	UL 3030		F	P
Standard Specification for Design, Construction, and Verification of Fixed-Wing Unmanned Aircraft Systems (UAS)	ASTM	F3298-19		F	P
Environmental Conditions and Test Procedures for Airborne Equipment	EUROCAE	ED14-G		P	P
Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	JARUS	CS-LURS		F	P
Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	JARUS	CS-LUAS		F	P
IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	IEC	IEC 60529		F	P

3.21.3 Coverage Detail

Table 356

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	

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Unmanned Aircraft Systems (UAS) - Product requirements	ASD-STAN	EN4709-001		F	P	The standard deals mainly with UAS in the category “open” below 25kg MTOM but it could be used as well for other UAS in the specific category to demonstrate that they are safely controllable and manoeuvrable under all anticipated operating conditions. Full coverage in “Medium” has been chosen as for OSO#24 (b) the lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

Notes:

1. Ongoing
2. This harmonised standard covers all the requirements defined in the Annex of Commission delegated Regulation (EU) 2019/945 for each of the five classes of UAS (C0 -C4) defined in Chapter II of this regulation, with the exception of direct remote identification, geo-awareness and lighting. It shall describe appropriate technical solutions and verification methods to ensure and demonstrate the conformity of the UAS with these requirements

Table 357

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
UAV System Airworthiness Requirements (USAR)	NATO	STANAG 4671		P	P	Only for fixed wing military UAS with MTOM >150 kg < 20.000kg

Notes:

1. Ongoing
2. Only an outdated version of this standard was publicly available under: https://www.defense.gouv.fr/content/download/552731/9407958/file/4671eed01.pdf
3. This document contains a set of technical airworthiness requirements intended primarily for the airworthiness certification of fixed-wing military UAV Systems with a maximum take-off weight between 150 and 20,000 kg that intend to regularly operate in non-segregated airspace. Certifying Authorities may apply these certification requirements outside these limits where appropriate.

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Table 358

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)	NATO	STANAG 4702		P	P	Only for military rotary wing UAS

Notes:

1. Published
2. Publicly available: https://www.uvsr.org/Documentatie%20UVS/Reglementari%20internationale/STANAG-uri/Standarde%20pt%20analiza%20UAV/STANAG/4702/AEP-80(A).pdftps://www.uvsr.org/Documentatie%20UVS/Reglementari%20internationale/STANAG-uri/Standarde%20pt%20analiza%20UAV/STANAG/4702/4702Ed01.pdf
3. This document contains a set of technical airworthiness requirements intended for the airworthiness certification of rotary-wing military UAV Systems with a maximum take-off weight between 150 and 3175 kg that intend to regularly operate in non-segregated airspace. Certifying Authorities may apply these certification requirements outside these limits where appropriate. These requirements represent the minimum acceptable airworthiness requirements for design and construction of military rotorcraft UAVs intended to operate in non-segregated airspace. It may be augmented by additional Special Conditions (i.e. additional airworthiness requirements) required by Certifying Authorities. The USAR-RW is intended for application by Certifying Authorities within each country's relevant national regulatory framework.

Table 359

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)	NATO	STANAG 4703		P	P	Only for military fixed wing UAS.

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Notes:
1. Published
2. Publicly available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/391827/2010916-STANAG-4703_AEP-83_A___1_.pdf
3. This document contains the minimum set of technical airworthiness requirements intended for the airworthiness certification of fixed-wing Light UAS with a maximum take-off weight not greater than 150 kg and an impact energy1 greater than 66 J (49 ft-lb) that intend to regularly operate in non-segregated airspace.

Table 360

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard for Unmanned Aircraft Systems	UL	UL 3030		F	P	Full coverage in "Medium" has been chosen as for OSO#24 (b) the lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

Notes:
1. Status: published
2. Recognized by Transport Canada (CAA)
3. The standard deals with Design of UAS <25kg and their intended operational spectrum (focused on electrical systems) and test methods for different conditions including adverse weather conditions. UASs covered by these requirements are intended to be operated by certified UAS pilots as identified in the Federal Regulations, where the unmanned aircraft is less than 25 kg (55 lbs). The UAS is intended to be provided with an internal lithium ion battery that is charged from an external source. UASs are intended to have an operating voltage of not greater than 100 V dc, and are intended for outdoor operation. These requirements also cover the electrical shock, fire and explosion hazards associated with the inherent features of these UASs, as well as the battery and charger system combinations provided for recharging the UAS.

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Table 361

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Standard Specification for Design, Construction, and Verification of Fixed-Wing Unmanned Aircraft Systems (UAS)	ASTM	F3298-19		F	P	Full coverage in “Medium” has been chosen as for OSO#24 (b) the lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

Notes:

1. Status: Published
2. The standard deals with Design of UAS <25kg and test methods for different conditions including adverse weather conditions like icing. This specification covers the airworthiness requirements for the design of light unmanned aircraft systems. This specification defines the baseline design, construction, and verification requirements for an unmanned aircraft system (UAS).

Table 362

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Environmental Conditions and Test Procedures for Airborne Equipment	EUROCAE	ED-14G		P	P	The standard only addresses classical manned aviation aircrafts and only Airborne equipment

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Notes:
1. Published
2. The standard cannot be downloaded but the subject can be identified by information provided from EUROCAE or RTCA under: https://do160.org/rtca-do-160g/
3. RTCA DO-160G provides standard procedures and environmental test criteria for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the "jumbo jets" and SST categories of aircraft. Coordinated with EUROCAE, RTCA DO-160G and EUROCAE ED-14G are identically worded. RTCA DO-160G is recognized by the International Organization for Standardization (ISO) as de facto international standard ISO-7137. These standards are developed to cover airborne equipment of manned aviation and could be potentially suitable for UAS airborne component. Conversely, the UAS ground component (e.g. ground control station) may be subject to different environmental conditions (e.g. pressure, temperature, etc..) so a dedicated standard should be developed.

Table 363

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)	JARUS	CS-LURS		F	P	The standard defines minimum design requirements but only for Light Rotorcraft UAS. Moreover the requirements contained in the document might be too demanding for a Low level of robustness. A guidance is needed to determine which subset of the proposed requirements should be used for each level of robustness. Full coverage in "Medium" has been chosen as for OSO#24 (b) the lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

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Notes:
1. The standard is a Certification Specification applicable to Light Unmanned Rotorcraft Systems with Light Unmanned Rotorcraft maximum certified take-off weights not exceeding 750 kg.
2. The CS generically refers to the need to develop system considering the applicable environmental conditions. In addition the following requirements are specifically applicable for this OSO:
   - CS-LURS.1317 High-Intensity Radiated Fields (HIRF) Protection
   - CS LURS.1093 Induction system icing protection
   - CS-LURS.867 Electrical bonding and protection against lightning and static electricity
   - CS-LURS.1316 Electrical and electronic system lightning protection

Table 364

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)	JARUS	CS-LUAS		F	P	The standard defines minimum design requirements but only for Light Aeroplane UAS. Moreover the requirements contained in the document might be too demanding for a Low level of robustness. A guidance is needed to determine which subset of the proposed requirements should be used for each level of robustness. Full coverage in "Medium" has been chosen as for OSO#24 (b) the lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

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Notes:

1. The standard is a Certification Specification applicable to Light Unmanned Aeroplane Systems with Light Unmanned Rotorcraft maximum certified take-off weights not exceeding 750 kg.
2. The CS generically refers to the need to develop system considering the applicable environmental conditions. In addition the following requirements are specifically applicable for this OSO:
   - CS-LUAS.1317 High-Intensity Radiated Fields (HIRF) Protection
   - CS LUAS.1093 Induction system icing protection
   - CS-LUAS.867 Electrical bonding and protection against lightning and static electricity
   - CS-LUAS.1316 Electrical and electronic system lightning protection

3.21.4 Gaps

No gaps were identified in OSO #24 for medium Integrity / robustness as the identified standards seem to cover adequately all the requirements. No existing or upcoming standard assessed by the consortium has been identified to fully cover "high" integrity / robustness criteria of OSO #24.

3.21.5 Conclusions and Recommendations

The table below provides the recommended standards for OSO #24. No standards are required for a medium level of robustness, so the proposed standards may be used as guidance.

Table 365 Recommended Standards

Integrity/Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
	Low	N/A	NO STANDARD REQUIRED			

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Criterion #1	Medium	FULL, BUT NO STANDARD REQUIRED. THE FOLLOWING CAN BE USED AS GUIDANCE	UL 3030 – "Standard for Unmanned Aircraft Systems"	Recognized by Transport Canada (CAA) Document deals with Design of UAS <25kg and their intended operational spectrum (focused on electrical systems) and test methods for different conditions including adverse weather conditions Also covers the electrical shock, fire and explosion hazards associated with the inherent features of UASs, as well as the battery and charger system combinations provided for recharging the UAS	12	
			IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	Standard applies to the classification of degrees of protection provided by enclosures for electrical equipment in general (not specific to UAS) with a rated voltage not exceeding 72,5 kV. Provides definitions for degrees of protection provided by enclosures of electrical equipment Provides designations for these degrees of protection including requirements for each designation Provides tests to be performed to verify that the enclosure meets the requirements of this standard	10	

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			ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"	Document deals with Design of UAS <25kg and test methods for different conditions including adverse weather conditions (ie. Icing)	8	
			EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"	covers all the requirements defined in the Annex of Commission delegated Regulation (EU) 2019/945 for each of the five classes of UAS (C0 -C4) below 25kg MTOM, with the exception of direct remote identification, geo-awareness and lighting describes appropriate technical solutions and verification methods to ensure and demonstrate the conformity of the UAS with these requirements	8	Only basic product requirements for UAS in "standard" environmental conditions
			JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	7	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness

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			JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	7	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
		Partial	EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"	Provides standard procedures and environmental test criteria for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the "jumbo jets" and SST categories of aircraft	2	The standard only addresses classical manned aviation aircrafts, Multi-rotor UA and remote-control station not covered
			NATO STANAG 4671 – "UAV System Airworthiness Requirements (USAR)"	Only for fixed wing military UAS with MTOM >150 kg < 20.000kg	1	Remote control station not covered
			NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"	Only for military rotary wing UAS	1	Remote Control station not covered
			NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"	Only for military fixed wing UAS	1	Remote Control station not covered

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	High	Partial	UL 3030 – "Standard for Unmanned Aircraft Systems"	Recognized by Transport Canada (CAA) Document deals with Design of UAS <25kg and their intended operational spectrum (focused on electrical systems) and test methods for different conditions including adverse weather conditions Also covers the electrical shock, fire and explosion hazards associated with the inherent features of UASs, as well as the battery and charger system combinations provided for recharging the UAS	8	
			IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	Standard applies to the classification of degrees of protection provided by enclosures for electrical equipment in general (not specific to UAS) with a rated voltage not exceeding 72,5 kV. Provides definitions for degrees of protection provided by enclosures of electrical equipment Provides designations for these degrees of protection including requirements for each designation Provides tests to be performed to verify that the enclosure meets the requirements of this standard	6	

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			ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"	Document deals with Design of UAS <25kg and test methods for different conditions including adverse weather conditions (ie. Icing)	4	
			EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"	Provides standard procedures and environmental test criterion for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the "jumbo jets" and SST categories of aircraft	4	The standard only addresses classical manned aviation aircrafts, Multi-rotor UA and remote-control station not covered
			NATO STANAG 4671 – "UAV System Airworthiness Requirements (USAR)"	Only for fixed wing military UAS with MTOM >150 kg < 20.000kg	3	Remote control station not covered
			NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"	Only for military rotary wing UAS	3	Remote Control station not covered
			NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"	Only for military fixed wing UAS	3	Remote Control station not covered

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			JARUS CS-LURS – “Certification Specification for Light Unmanned Rotorcraft Systems”	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	3	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
			JARUS CS LUAS – “Certification Specification for Light Unmanned Aeroplane Systems”	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	3	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
			EN4709-001 – “Unmanned Aircraft Systems (UAS) - Product requirements”	covers all the requirements defined in the Annex of Commission delegated Regulation (EU) 2019/945 for each of the five classes of UAS (C0 -C4) below 25kg MTOM, with the exception of direct remote identification, geo-awareness and lighting. describes appropriate technical solutions and verification methods to ensure and demonstrate the conformity of the UAS with these requirements	3	Only basic product requirements for UAS in “standard” environmental conditions

3.22 Adjacent Area/Airspace Considerations

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3.22.1 Requirement Description

Table 366 Requirements' Description

Criterion	Applicability	Description
1	Always	No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume. Compliance with the requirement above shall be substantiated by a design and installation appraisal and shall minimally include: • design and installation features (independence, separation and redundancy); • any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the ConOps.
2	If adjacent areas are: 1. Gatherings of people unless already approved for operations over gathering of people OR 2. ARC-d unless the residual ARC is ARC-d In populated environments where: 1. M1 mitigation has been applied to lower the GRC 2. Operating in a controlled ground area	1. The probability of leaving the operational volume shall be less than 10-4/FH. 2. No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer. *Compliance with the requirements above shall be substantiated by analysis and/or test data with supporting evidence.* 3. Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could directly lead to operations outside of the ground risk buffer shall be developed to an industry standard or methodology recognized as adequate by the competent authority.

3.22.2 Summary

Table 367 Adjacent Area Standards' effectiveness in fulfilling the requirement (in order of ranking)

Standard Title	SDO	Doc. Reference	Criterion 1	Criterion 2

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				1	2	3
Minimum Operational Performance Specification Geocaging	EUROCAE	ED-270		F		
Minimum Operational Performance Specification Geofencing	EUROCAE	ED-269		F		
Design Assurance Guidance for Airborne Electronic Hardware	EUROCAE/RTCA	ED-80/ DO-254				P
Software Considerations in Airborne Systems and Equipment Certification	EUROCAE/RTCA	ED-12/DO-178				P
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3309			F	
Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761A			F	
Software Considerations in Lower Risk Applications, Equipment Certifications and Approvals	EUROCAE	N.A.				(P)
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F		F	

3.22.3 Coverage Detail

Table 368

Standard Title	SDO	Doc. Reference	Criterion 1	Criterion 2			Gaps
				1	2	3	
Minimum Operational Performance Specification Geocaging	EUROCAE	ED-270		F			

Notes:

A system developed according to this standard is expected to limit the probability of leaving the operational volume to less than 10-4/FH

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Table 369

Standard Title	SDO	Doc. Reference	Criterion 1	Criterion 2			Gaps
				1	2	3	
Minimum Operational Performance Specification Geofencing	EUROCAE	ED-269		F			
Notes: A system developed according to this standard is expected to limit the probability of leaving the operational volume to less than 10-4/FH							

Table 370

Standard Title	SDO	Doc. Reference	Criterion 1	Criterion 2			Gaps
				1	2	3	
Design Assurance Guidance for Airborne Electronic Hardware	RTCA/EUROCAE	DO-254/ED-80				P	The standard only addresses Hardware

Table 371

Standard Title	SDO	Doc. Reference	Criterion 1	Criterion 2			Gaps
				1	2	3	
Software Considerations in Airborne Systems and Equipment Certification	EUROCAE/RTCA	ED 12/DO-178				P	The standard only addresses Software

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Table 372

Standard Title	SDO	Doc. Reference	*Criterion 1*	*Criterion 2*			Gaps
				1	2	3	
Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	ASTM	F3309			F		This standard is not specific for UAS.

Table 373

Standard Title	SDO	Doc. Reference	*Criterion 1*	*Criterion 2*			Gaps
				1	2	3	
Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	SAE	ARP4761A			F		This standard is not specific for UAS.

Table 374

Standard Title	SDO	Doc. Reference	*Criterion 1*	*Criterion 2*			Gaps
				1	2	3	
Software Considerations in Lower Risk Applications, Equipment Certifications and Approvals	EUROCAE	N.A.				(P)	This standard is expected to provide guidance on SW Development Assurance for low risk applications (e.g. COTS products). At the time of this report, the work is still in progress so a proper evaluation could not be conducted.

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Table 375

Standard Title	SDO	Doc. Reference	*Criterion 1*	*Criterion 2*			Gaps
				1	2	3	
Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	EUROCAE	ED-280	F		F		This document summarizes the proposed procedure that a UAS operator or manufacturer has to perform in order to develop the functional hazard assessment and the safety analysis required to fulfil OSO#5 requirements at Low and Medium Robustness. However, it can be used also to fulfil this criterion effectively together wit ED-279 that is referenced in it.

3.22.4 Gaps

3.22.4.1 Summary

Table 376 Gap Summary – Adjacent Area

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	There is a lack of standards for SW and airborne electronic hardware (AEH) Development Assurance that are suitable for small UAS	-9	It is recommended to develop a standard for SW and AEH development assurance that is suitable for small UAS. EUROCAE WG-117 activity on this topic is expected to cover this gap for the part related to software.

3.22.4.2 Details

Table 377

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score

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1	There is a lack of standards for SW and airborne electronic hardware (AEH) Development Assurance that are suitable for small UAS	Safety (3)	High	A lack of standards does not guarantee a way to assess whether the current means adopted by drone manufacturers to comply with the requirement is reliable.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Very High	Complying to requirements born to suit only larger aircrafts is time consuming and expensive.	-2	-4
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Very Negative	A very high cost of compliance will reflect analogously on EU industries.	-2	-2
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-9**

3.22.5 Conclusions and Recommendations

The available standards are generally covering adequately the criteria for adjacent area/airspace. There is only a lack of guidance for the Software Development assurance aspects for small COTS products, but this is expected to be covered by the standard under development within EUROCAE WG-117.

Table 378 Recommended Standards

Criterion	Requirement	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	All	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		13	
	1	Full	EUROCAE ED-270 MOPS Geocaging		13	

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Criterion #2		Full	EUROCAE ED-269 MOPS Geofencing		13	
	2	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	This standard is more suitable for small UAS	11	
			ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	This standard is more suitable for larger UAS	12	
			SAE ARP4761A Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	This standard is more suitable for larger UAS	10	
	3	Partial	RTCA/EUROCAE DO-254/ED-80 Design Assurance Guidance for Airborne Electronic Hardware	This standard might be too demanding for small UAS. It would provide Full coverage to the AEH part of the criterion.	6	There is a lack of standard for SW and AEH Development Assurance that are suitable for small UAS
		Partial	EUROCAE/RTCA ED 12/DO-178 Software Considerations in Airborne Systems and Equipment Certification	This standard might be too demanding for small UAS. It would provide Full coverage to the SW part of the criterion	6	
		(Partial)	EUROCAE WG-117 Software Considerations in Lower Risk Applications, Equipment Certifications and Approvals	This standard is expected to be more suitable for small COTS UAS, however it cannot be evaluated due to its early stage of development	N.A.	

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4 Conclusions and recommendations

From the analysis presented in this document the following conclusions can be made:

1. For most SORA criteria there is partial coverage by existing standards, some have full coverage. Partial coverage means that a standard:
   - Has a low maturity because it is still in a development phase, or
   - Covers only a part of a SORA criterion, or
   - Has a limited scope (e.g. MTOM less than 25kg, only rotorcraft, etc.), or
   - It was developed for manned aviation not practical for the UAS sector because it is too demanding;
2. Some SORA criteria may become fully covered if standards under development indeed provide what is advertised in e.g. terms of reference or summaries; in this report these standards are indicated between brackets and not (yet) recommended, they should be assessed when they are published.
3. Given the above, the analysis identified the following standards as those that can be already recommended for actual use (for the details on the level of coverage see the detailed analysis above):
   - M1 – Strategic mitigations for Ground Risk - Non-tethered M1 mitigations
     - Methodology for the UAS Operational Risk for non-geographical flight permits – ENAC-LG 2017/001-NAV
     - DGAC - AÉRONEFS CIRCULANT SANS PERSONNE A BORD: ACTIVITÉS PARTICULIÈRES Ed 1 rev. 4
     - EUROCAE ED-270, Geocaging Appendix 1
   - M1 – Strategic mitigations for Ground Risk - Tethered M1 mitigations
     - ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category
     - ISO/FDIS 21384-3 Unmanned aircraft systems — Part 3: Operational procedures
   - M2 – Effects of UA Impact Dynamics are Reduced
     - F3322-18 Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes
   - M3 – An Emergency Response Plan is in place, operator validated and effective
     - ISO 21384-3: Operational Procedures
     - IATA Emergency Response Plan
   - Tactical Mitigations Performance Requirements - VLOS
     - F1583-95 (2019): Standard Practice for Communications Procedures – Phonetics
   - Tactical Mitigations Performance Requirements - BVLOS
     - DO-365: MOPS for Detect and Avoid (DAA) Systems - Phase 1
     - DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications
     - ED-258: Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR
     - ED-267: Operational Services and Environmental Description for DAA in Very Low-level Operations

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- DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications
- ED-271: MASPS for Detect & Avoid [Traffic] in Class A-C airspaces under IFR
- DO-366: Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance
- ED-265: Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)

- OSO #1 – Operator competent and/or proven
  - ISO 21384-3 UAS – Part 3: Operational Procedures
  - F3178-16: Standard practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)
  - ASTM F3364-19: Standard practice for independent audit program for unmanned aircraft operators
- OSO #2 – UAS manufactured by competent and/or proven entity
  - F2972 – 15 Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System
  - F3003-14 Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)
  - ISO 9001:2015 Quality Management System
  - EN 9100:2018 Quality Management Systems - Requirements for Aviation, Space and Defence Organizations
  - ASTM F2911-14e1: Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)
- OSO #3 – UAS maintained by competent and/or proven entity
  - ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems
  - ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft
  - ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)
- OSO #4 - UAS developed to authority recognized design standards
  - To be completed after coordination with EASA
- OSO #5 - UAS is designed considering systems safety and reliability
  - ASTM F3309 – Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
  - SAE ARP4761 – Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
  - EUROCAE ED-79 Guidelines for Development of Civil Aircraft and Systems
  - EUROCAE/RTCA ED-12C/DO-178 Software Considerations in Airborne Systems and Equipment Certification
  - EUROCAE/RTCA ED-80/DO-254 Design Assurance Guidance for Airborne Electronic Hardware
  - EUROCAE ED-280: Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
  - EUROCAE ED-279: Generic Functional Hazard Assessment (FHA) for UAS/RPAS
  - EUROCAE ED-79A Guidelines for Development of Civil Aircraft and Systems

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- ASTM F3230: Practice for Safety Assessment of Systems and Equipment in Small Aircraft
- OSO #6 – C3 link characteristics appropriate for the operation
  - ASTM F3002 – 14 - Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)
  - IEEE 802.11, IEEE 802.11a – WIFI technology (2.4 GHz + 5 GHz Band)
  - IEEE 802.15.1 – Bluetooth technology
  - IEEE 802.22 - Wireless regional area network (WRAN)
  - 3GPP - TR 36.777 Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles
  - EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS
  - RTCA DO-362 - Command and Control (C2) Data Link Minimum Operational Performance Standard (MOPS) (Terrestrial)
  - EUROCAE ED-265 - Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)
- OSO #7 – Inspection of the UAS (product inspection) to ensure consistency to the ConOps
  - ISO 21384-3: Operational Procedures
  - ISO 23665 – Training for personnel involved in UAS operations
- OSO #08, 11, 14, 21 – Operational Procedures
  - ISO 21384-3: Operational Procedures
- OSO #09, 15, 22 - Remote Crew Competencies
  - F3330-18: Standard specification for Training and the Development of Training Manuals for the UAS Operator
  - JARUS Recommendations for RPC
  - ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations
  - ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations
- OSO #10,12 – Safe recovery from technical issues
  - ASTM F3309 – Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
  - F3230-17: Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft
  - ED-79A/ARP4754A: Guidelines for Development of Civil Aircraft and Systems
  - ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
- OSO #13 – External services supporting UAS operations are adequate to the operation
  - ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures
  - ISO 21384-2 - Unmanned aircraft systems -- Part 2: Product systems
  - 16803-1:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part1- Definitions and system engineering procedures for the establishment and assessment of performance
  - 16803-2:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals

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- Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.
- ISO 23629-12 - Requirements for UTM services and service providers

- OSO #16 – Multi-crew coordination
  - No appropriate standard available yet or available for review
- OSO #17 – Remote crew is fit to operate
  - ISO 21384-3 UAS – Part 3: Operational Procedures
- OSO #18 – Automatic protection of the flight envelope from human errors
  - STANAG 4671 – UAV System Airworthiness Requirements (USA)
  - STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements
  - JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)
  - JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)
- OSO #19 – Safe recovery from Human Error
  - ISO 21384-3 UAS – Part 3: Operational Procedures
  - F3330-18: Standard specification for Training and the Development of Training Manuals for the UAS Operator
  - JARUS Recommendations for RPC
  - ASTM F3266-18
  - ASTM F3379-20
  - ISO 23665
  - ARP5707
  - Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)
- OSO #20 – A Human Factors evaluation has been performed and the Human-Machine Interface (HMI) found appropriate for the mission
  - UAV System Airworthiness Requirements (USAR) - UAS GCS Human systems Integration (HSI) Guidance and Human Factors (HF) Airworthiness considerations (based on STANAG 4671) – DRDC
  - STANAG 4703
  - SESAR Human Performance Assessment (HPA)
- OSO #23 - Environmental conditions for safe operations defined, measurable and adhered to
  - ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures
  - F3330 – 18 Standard Specification for Training and the Development of Training Manuals for the UAS Operator
  - Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)
  - DOC - 1009 - Manual on Remotely Piloted Aircraft Systems (PSURs)
  - ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations
  - ARP 5707
- OSO #24 – UAS designed and qualified for adverse environmental conditions

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    - JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"
    - JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"
    - ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"
    - UL 3030 – "Standard for Unmanned Aircraft Systems"
    - IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"
    - RTCA DO-160 – "Environmental Conditions and Test Procedures for Airborne Equipment"
    - EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"
    - NATO STANAG 4701 – "UAV System Airworthiness Requirements (USAR)"
    - NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"
    - NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"
    - EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"
    - EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"
  - Adjacent Area/Airspace Considerations
    - EUROCAE ED-270 MOPS Geocaging
    - EUROCAE ED-269 MOPS Geofencing
    - EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
    - ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
    - SAE ARP4761A Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
    - RTCA/EUROCAE DO-254/ED-80 Design Assurance Guidance for Airborne Electronic Hardware
    - EUROCAE/RTCA ED 12/DO-178 Software Considerations in Airborne Systems and Equipment Certification

Given the above, it is recommended that:

- The maturity of the standards is continuously monitored to update the assessment. This will be done throughout the AW-Drones project.
- The coverage identified in this document is published by the project as the unique European Meta-Standard supporting the application of the SORA methodology for the specific category of operations.
- The European Commission, supported by EASA, should bring the gaps identified in paragraph 2.2 to the attention of the European UAS Standard Coordination Group (EUSCG) to possibly initiate actions to fill the gap.

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5 References

[1] EASA (2019, AMC & GM to Commission Implementing Regulation (EU) 2019-947 - Issue 1
[2] AW-Drones (2019), D2.2: Methodology for the assessment of drone standards
[3] EASA (2017), Research Programme On Collision with Drones: Work Area 1 Final Report, Issue 4.0
[4] SJU (2016), SJU European Drones Outlook Study
[5] European Union (2019), Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft

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Annex 1 Standards' assessment

1. Complete Standards' Assessment for each SORA criterion: https://seafile.dblue.it/f/32b5ba1a8e034a3981f8/

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AW-Drones proposed standards – 2nd iteration (U-Space)

D4.2

AW-Drones

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AW-Drones

Abstract

The AW-Drones project aims at supporting the European drone regulatory framework by identifying consensus-based voluntary standards which are deemed suitable to support the UAS common European rules at the level of Acceptable Means of Compliance (AMC) in the perspective of the "Performance-Based Regulation".

The Performance-Based Regulation in fact postulates that AMC should be published in a large proportion not by Authorities, but by Standard Development Organisations (SDOs).

This document presents the results deriving from the assessment of standards, published or under advanced development by SDOs, considered potentially compliant to the requirements set in the Draft Commission Implementing Regulation on a regulatory framework for the U-space [3], including not only related airborne functions, but also service provision.

For each U-space service, this document provides a list of standards offering at least a partial coverage, identification of the gaps which prevent a complete coverage, and conclusions & recommendations to cover each gap for fully meeting the requirement.

The recommendations may be used by EASA to publish a list of AMC acceptable to the Agency, or by the European UAS Standard Coordination Group (EUSCG) where SDOs could discuss how to fill the gaps.

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Introduction

1.1 Standards' assessment in the context of AW-Drones

The lack of clear and clearly identified standards is holding back the development of the drone-related business, both at a global level and in Europe. Several studies and surveys identify a comprehensive regulatory and standardisation framework as a main potential booster for the drone business. Therefore, to foster the growth of a safe drone usage, there is a need to implement coherent and interoperable global standards compliant with the regulations for drones in the European Union. The EU's Horizon 2020 Research and Innovation Program funded Project AW-Drones to tackle these issues and guide future EU drone regulation, mainly at the level of so-called "soft rules". i.e. consensus-based voluntary standards produced by Standard Development Organisations (SDOs) for voluntary application supporting the Commission Regulations (legally binding "hard rules") at the level of Acceptable Means of Compliance (AMC).

The idea that regulatory material adopted by Authorities could be complemented by consensus-based standards emerged in civil aviation in 1998, through Resolution A32-14 adopted by the ICAO General Assembly. The concept in EU is often referred as "Performance-Based Regulation" meaning that EASA could enshrine standards published by SDOs at the level of AMC, instead of directly drafting such material.

AW-Drones contributes to supporting the European Union's drone "hard" regulations through identification of suitable standards, enabling safe, environmentally sound and reliable operations of non-military drones in the European Union.

In order to achieve this objective, one of the sub-goals of the project is to propose a well-reasoned set of technical standards for operations and for U-space services, appropriate for all relevant categories of drone operations.

A work plan has been formulated to collect and assess existing and planned standards. The effort is split into three main technical work packages (WP):

- WP2 - Development of a methodology for categorization and assessment
- WP3 - Collection and categorization of standards that might be applicable for UAS
- WP4 - Assessment of these standards to evaluate their feasibility to support this process in order to derive a set of standards that are validated and found applicable.

While the first activity was carried out only at the beginning of the project to set the ground for all the subsequent work, both the data collection and the assessment of the standards is carried out iteratively over the course of the three years of the project. In particular during the first year (2019) the project focused on the collection and assessment of standards potentially suitable to support the demonstration of compliance to the criteria in the Specific Operations Risk Assessment methodology (SORA), which was released in deliverable D4.1.

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The SORA methodology, developed by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) is officially transposed in the EU regulatory framework by EASA as Acceptable Means of Compliance (AMC) No.1 to Article 11 of EU Regulation 2019/947 [1].

This deliverable D4.2 instead focuses on assessment of standards deemed suitable to support verification of conformity of identified U-Space services and related airborne functions.

With reference to deliverable D2.3 of the project [2], it was, by lack of AMC's, agreed with EASA to identify and assess with priority standards for the two services that are planned to be operational shortly: the Network Identification Service (NIS) and the Geo-Awareness Service (GAW). Even more specifically, the identified and assessed standards are aimed mainly to cover the aspects from a U-space service provider point of view.

However, this first version already contains all the potential U-space services presently known, and lists standards identified as a possible AMC. Some of these standards are still under development, while additional standards may emerge in the near future.

Therefore, the third iteration of AW-Drones will hand upcoming updates in the next issue of this document.

EASA is working on AMC guidance material (GM):

- work conducted in the AW-Drones project will be used for EASA's development on AMC GM
- divided in WP's (6 out of them (15) ref. to USS's)
- AMC GM expected to be ready by the end of October
- The AMC GM task force is currently working on NIS, GAS and FAS

1.2 Purpose and scope of this document

Based mainly on EASA Opinion No 01-2020 [3] on the high-level framework for the U-space and the draft of the Commission Implementing Regulation on a regulatory framework for the U-space [4], an architecture has been taken as a starting point for collecting standards related the mandatory U-space services, supporting services and related services.

The assessments are based on the methodology already defined in work package (WP) 2. This document contains the summary of the identified standards for each U-space service, a gap assessment as well as conclusions and recommendations. The assessments of the individual standards are contained in a separate tool, based on the aforementioned methodology.

1.3 Structure of the document

The structure of this document is based on the U-space services. For each service, there is a separate chapter including a description of the service and the identified standards, a summary,

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gaps identified and conclusions & recommendations. The assessments themselves are done in a separate Excel file: 'AW-Drones_D4.2_Annex_U-Space_Standards assessment.xlsx' [Annex V].

In chapter 2 some background information is given on U-space, as well as a schematic presentation of the U-space architecture used in the project, based on the already mentioned publications (sources [2] & [3]).

Chapter 3 to 8 addresses the U-space services, chapter 9 covers additional services and interfaces.

Annex I presents the identified standards per USS/Category and per SDO. It also presents a table suggesting standards and publications to be screened on potentially being suitable to cover U-space requirements

1.4 How to read this document

This section includes the used abbreviations and highlights the main features of the tables describing the assessment the standards. It explains how the information is presented and how to effectively read the results presented.

1.4.1 List of acronyms

AMC	Acceptable Means of Compliance
ASTM	American Society for Testing and Materials International
ATM	Air Traffic Management
CD	Committee Draft
CMS	Conformance Monitoring Service
CU	Command Unit
DOC	Designated Operational Coverage
DRI	Direct Remote Identification
GAW	Geo-Awareness service
NIS	Network Identification Service
EASA	European Union Aviation Safety Agency
EDPS	European Data Protection Supervisor

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FCS	Flight Clearance (alias authorisation) service
MOPS	Minimum Operational Performance Specification
MS	Member States
SDO	Standard Development Organization
EU	European Union
SORA	Specific Operations Risk Assessment
TIS	Traffic Information Service
TRS	Tracking Service
UAS	Unmanned Aircraft System
UCS	UTM Communication Service
USSP	U-space (alias UTM) service provider
UTM	UAS Traffic Management (equivalent to U-space)
WIS	Weather Information Service
WP	Work Package

1.4.2 Summary table

The summary table in each chapter includes the identified standards that could be considered by EASA as candidates to be published by the Agency as possible AMCs for the U-space services. Such tables include following columns:

Table 1 Example of Summary Table

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score

Standard title

The title of the document assessed, which can be a in a Planning, Drafting, Internal Consultation, External Consultation or Published phase. Please note different maturity terminologies are used amongst different SDO's, therefor a Maturity Correlation Table is provided in Annex III.

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SDO

The Standard Design Organisation (alias standard making body) which has published or which is producing the standard.

Doc. Ref.

The respective document reference

Status, scope & compatibility

Contains more info on the status of the document (Planning, Drafting, Internal Consultation, External Consultation, or Published), the scope of the document that matches the U-space service, and if this standards doesn't, partially of fully covers requirements. It might also contain the name of the working group.

Since different SDOs use different semantics to identify stages of respective developments, a correlation table is provided in Annex III.

Global score

This column presents a global score obtained by assessing each standard according to the methodology described in [2].

1.4.3 Gap summary

The gap summary table highlights the identified gaps missing to cover the requirements for the specific U-space requirement. The columns are divided as follows:

Table 2 Example of Gaps' Summary table

Gap #	Gap Description	Conclusion Recommendation

Gaps and Gap Description

Provides a number for each gap identified, explaining the nature of the gap and its rationale. The gaps listed in this table are generally not the same identified in the assessment of the individual standards, but rather gaps to fully cover the U-space service requirement, taking in consideration all currently available standards.

Conclusions and Recommendations

It provides conclusions on gaps which have been identified, with recommendations in relation to the severity of each respective score.

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In the framework of identifying gaps related to U-space service requirements, no quantitative assessments of the consequences of the gaps has been carried out.

1.4.4 Conclusions & recommendations

This section gives an overview of the current coverage of each requirement identified for the specific U-space service, providing a table with the best identified standards that cover the requirement at present, alongside any associated limitations and gaps.

Table 3 Example of Conclusions table

Requirement	Coverage	Recommended standards	Limitations/notes	Gaps

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2 Background information

2.1 U-space Services

AW-Drones considered only the 7 U-space Services listed in Chapter IV (U-space services) of Opinion No 01-2020 high level framework for the U-space [3] and related Draft Commission Implementing Regulation on a regulatory framework for the U-space [4] during the project. The current draft of the latter in fact specifies the following 6 services:

1. **Network identification service (NIS)**
   a. A network identification service should provide the identity of UAS operators and location of UAS during operations and in contingency situations, and share relevant information with other U-space airspace users.

2. **Geo-awareness service (GAW)**
   a. A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services.

3. **(UAS) flight authorisation service (alias Flight Clearance Service – FCS)**
   a. A flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified flight authorisations within the same U-space airspace.

4. **Traffic information service (TIS)**
   a. A traffic information service should alert UAS operators about other air traffic that may be present in proximity to their UAS.

5. **Weather information service (WIS)**
   a. A weather information service should support the UAS operator during the flight planning and execution phases, as well as improve the performances of other U-space services provided in the U-space airspace.

6. **Conformance monitoring service (CMS)**
   a. A conformance monitoring service should provide real-time alerting of non-conformance with the granted flight authorisation and inform the UAS operators when deviating from it.

It could be noticed that these listed 6 U-space services are all mentioned in draft ISO CD 23629-12 [5]; but the latter, based on CORUS, identifies more than 25 UTM services, categories into "safety-critical", "safety-related" and "operation support".

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2.2 U-space architecture

EASA and the Commission defined that the architecture needed for a successful implementation of U-space would be one with two types of service providers, being the 'Common Information Service Providers' and the 'U-space Service Providers'.

Further details on the possible U-space architecture are contained in [6].

Common Information Service Provider (CISP)

A Common Information Service Provider will be designated by Member States for every U-space airspace, as a single trustworthy source of reference information for the given U-space airspace for authorities, service providers and operators to enable the safe management of UAS operations. The CISP will support the exchange of information and the coordination between U-space service providers and air traffic service providers, without discrimination, to enable the safe management of unmanned aircraft traffic and segregation of manned aircraft from unmanned aircraft in the U space airspace under his jurisdiction.

A single standard of data will be needed:

- standard to be identified by EASA, currently left to the MS
- an open communication protocol standard is requested by EASA
- SWIM & Asterix to be further investigated

U-space service providers (USSP)

U-space service providers will act as gateway to U-space for Unmanned Aircraft Operators, they will provide the following minimum mandatory U-space services:

- Network Identification Service (safety-related in [5])
- Geo-awareness Service (safety-critical in [5])
- UAS Flight Authorisation Service (safety-critical in [5])
- Traffic Information Service (safety-critical in [5])

Mandatory vs supporting services

Next to the mandatory services above, following services are seen as supporting services but may be obligatory if deemed necessary by a Member State (MS):

- Weather Service (safety-related in [5])
- Conformance monitoring service (safety-critical in [5])

Related services

The following additional services may be offered as a service by the USSP or other authorised entity:

- ATM-CISP Interface

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- UTM Communication service (UCS) (safety-related in [5])

Unmanned aircraft operators may only operate in U-space airspace if they use the mandatory U-space services that are indispensable to ensure safe, secure, and efficient operations.

Note: in the Opinion No 01-2020 - high level framework for the U-space [3] 'tracking' service (TRS) was proposed as a U-space service, this however is currently not mentioned in the Draft Commission Implementing Regulation on a regulatory framework for the U-space [4]. In any case TRS is listed as safety critical service in [5].

Definition

No formal UTM (alias U-space) definition is yet published either by ICAO, EC or EASA. In this document the following definition from [5] is hence used:

UAS Traffic Management (UTM) Set of traffic management and air navigation services aiming at safe, secure and efficient integration of multiple manned and unmanned aircraft flying inside the respective DOC of each service. Note 1 to entry The definition is adapted from the ICAO Common UTM Framework with Core Principles for Global Harmonisation, 2nd edition, Nov. 2019 Note 2 to entry: In compliance with ICAO, Global Air Traffic Management Operational Concept, Doc 9854, 1st edition, 2005, UTM services initiate when the UAS operator files a request for clearance to enter airspace and terminates when the UA reaches the parking position, the primary propulsion systems are switched off and the operational plan is closed.

Architecture

The architectural diagram below is based both the before mentioned Opinion No 01-2020 - high level framework for the U-space [3] and the Draft Commission Implementing Regulation on a regulatory framework for the U-space [4].

The services which will be provided by the USSP are mentioned and described in the following chapters. The services/data which are mentioned in the architecture in the CISP system are interpreted as required to be provided by the CISP.

The architectural diagram displays the information flows. The services and flows are displayed as in the legend below. Optional/supporting services are dependent per Member State (MS).

The following legend is used:

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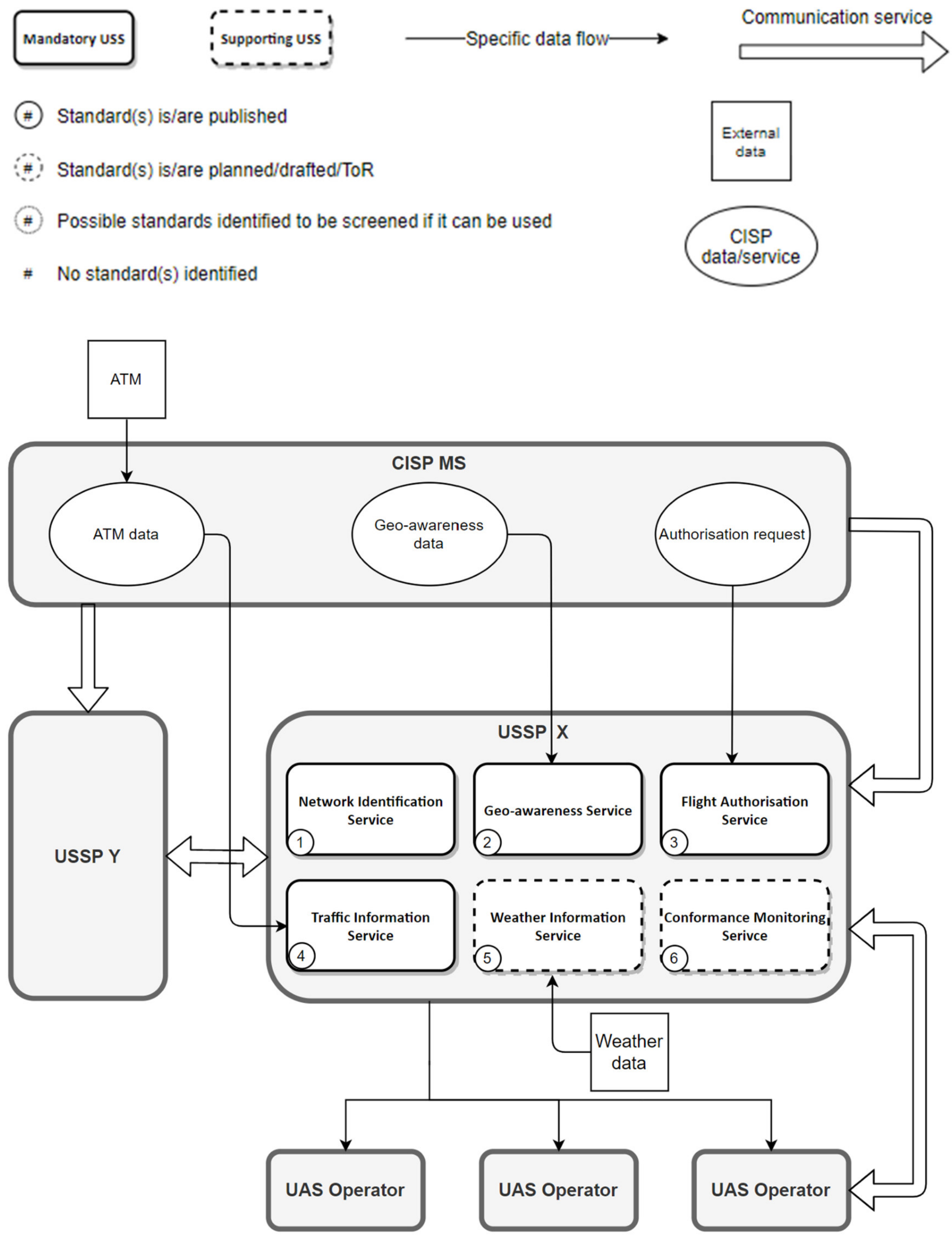

Figure 1 U-space architecture

The numbers shown in the diagram are also shown next to each chapter title for reference.

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3 Network identification service ①

3.1 Description

The detailed description of this service, according the 2020 draft U-space regulation, is:

A network identification service shall allow the continuous processing of the remote identification of the UAS throughout the whole duration of the flight and shall provide the remote identification of the UAS to authorised users in an aggregated manner.

The network identification service shall allow that the authorised users receive the messages with the following content:

a) The UAS operator registration number.
b) The unique serial number of the UA (or exclusively the Add-on) compliant with standard ANSI/CTA-2063-A-2019.
c) The time stamp, the geographical position of the UA and its height above the ground or its take-off point.
d) The route course measured clockwise from true north and ground speed of the UA.
e) The geographical position of the remote pilot, or if not available, the geographical position of the take-off point.
f) The UAS emergency status for Class C1, C2, C3. Not required for Add-on

The authorised users shall be:

- the general public as regards information that is deemed public in accordance with applicable Union and national rules;
    - Note: General public will have access to DRI, but not to NIS (see 1.2.3)
- other U-space service providers in order to ensure safety of operations in the U-space airspace;
- the air traffic services providers concerned;
- the competent authorities.

3.1.1 Network Identification Service (NIS) vs Direct Remote Identification (DRI)

The Implementing Regulation (EU) 2019/947 defines Direct Remote Identification (DRI) as a requirement for an airborne function in the Open Category. The network identification service requirements, in case a drone in either class C1, C2 or C3 would be equipped with such function, are included in Commission Regulation (EU) 2020/1058 . The difference between direct remote identification and network identification is described below.

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Direct remote identification means a system that ensures the local broadcast of information about an unmanned aircraft in operation, including the marking of the unmanned aircraft, so that this information can be obtained without physical access to the unmanned aircraft.

Direct remote identification is a method where the UAS is broadcasting the identification information which should be able to be received by mainstream smartphones.

Network Identification Service is a service where identification information is transmitted to the USSP through infrastructure such as LTE or satellite, managed by a provider of UTM Communication Service (UCS) where the identification and position information is continuously exchanged between service providers, if authorised.

Note: in the ASD STAN the terminology used for NIS is NRI (Network remote Identification), while in [5] it is NIS.

Neither DRI nor NIS are necessary to ensure airworthiness of the drone. In fact, DRI is necessary for enforcement, security and privacy considerations. Conversely NIS may be an operational requirement stemming form the airspace access rules.

3.1.2 Readiness of the mobile network to communication in U-space

The existing mobile networks can be reused without the need to deploy dedicated infrastructure for coverage in the air but limited in altitude due to antenna's directed towards the ground. In future deployments of 5G infrastructure the antenna pointing could be improved to allow NIS at higher altitudes. 3GPP standards are defined to provide global interoperable and secure connectivity. At present, mobile networks have sufficient capabilities to deliver connectivity, real-time data, security, and identity management for supporting U-space requirements. As mobile operators maintain and upgrade their existing infrastructure to 5G, their networks' capabilities will expand further.

There are concerns when using existing infrastructure in combination with the current LTE connectivity. Having too many drones in the air connected to the same pylon may decrease connectivity for all mobile users.

In any case [5] already contains safety and quality requirements for the related UCS providers, being this service considered safety-related by current ISO draft. Conformity with the applicable requirements could hence be verified through industry mechanisms, without involvement of the aviation authorities.

3.1.3 ASTM - F3411 – 19: UAS Remote ID and Tracking

During operation of the UAS, a Unique Operator's ID, (and possibly other codes, like e.g. the drone serial number) along with location and vector (speed/direction) will be communicated at a regular interval such that a compliant receiver will be able to identify an aircraft that is

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within operating range of the receiver for broadcast mechanisms and network range for network mechanisms.

Remote ID allows public and civil (i.e., government law enforcement agencies and private citizens) identification of UAS for safety, security, and compliance purposes, including for security and privacy purposes. The objective is to increase UAS operator accountability by removing anonymity while preserving operational and personal privacy for remote pilots, businesses, and their customers (with the European GDPR regulation [7] in mind).

This standard defines message formats, transmission methods, and minimum performance standards for two forms of Remote ID: broadcast and network. Broadcast Remote ID is based on the transmission of radio signals directly from a UAS to receivers in the UAS's vicinity. Network Remote ID is based on obtaining UAS remote identification information via the internet from a Network Remote ID Service Provider (Net-RID SP) that interfaces directly or indirectly with the UAS, or with other sources in the case of Non- Equipped Network Participants.

The term Broadcast Remote ID in this standard is equivalent to DRI in Commission Delegated Regulation 2019/945.

This standard is partially suitable to support the EU U-space draft Regulation, but gaps are being addressed in ASTM's current revision.

As NIS is currently not needed in FAA regulation, ASTM is working with Eurocae to address a global standard for NIS.

3.1.4 EUROCAE - ED-282: MOPS for UAS E-Identification

EUROCAE is developing ED-282 in coordination with ASD-STAN D05/WG08 for DRI. The "Open" (alias external) consultation on this standard was closed in August 2020. At beginning of 2021 EUROCAE is disposing the received comments to prepare the ED for publication.

Draft ED-282 'Minimum Operational Performance Standard for UAS E-Identification' specifies the minimum performance expected from e-Identification solutions for UAS and focuses on the E-Identification function meant to provide surveillance information generated by the UAS itself or its remote pilot station (RPS).

It does neither contrast ASTM F3411-19 nor prEN 4709-002, but the ED focuses on the network segment enabling the TRS.

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3.1.5 ASD-STAN - prEN 4709-002: Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification

This standard is defined in coordination with EUROCAE WG-105 SG-32 'UTM E-Identification' and ASTM. This standard was under "Enquiry" (i.e. external consultation) by CEN until 25 February 2021 and has a focus on Direct Remote Identification, which is a requirement in the implementing regulation for the open category.

Current outstanding challenges: in the delegated act it is specified that all information for DRI must protect the identification of the user.

The EDPS recommends that the Commission encourages RPAS manufacturers to implement privacy by design and by default and data controllers to carry out data protection impact assessments where processing operations present specific risks to the rights and freedoms of data subjects (i.e. citizens) by virtue of their nature, scope or purposes. As a consequence, the CEN prEN4709-002 standard does not cover the Remote Pilot/Operator privacy and data protection by design, and by default.

3.1.6 ISO - 23629-8: Remote identification

ISO started the development of an international standard on Remote ID. having approved the New Work Item Proposal (NWIP) on 22 June 2020. However, currently only the outline is available.

3.2 Summary

Table 4

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
UAS Remote ID and Tracking	ASTM	F3411-19	• Published • Version (date): February 28th 2020 • Prep. by WK65041 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: partially, but gaps are being addressed in ASTM's current revision.	16

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for UAS E-Identification	EUROCAE	ED-282	• External consultation • Version (date): June 2020 • Prep. by WG-105 SG-32 • NIS + DRI • Compliant with draft U-space regulations: yes, but demanding and thus expensive requirements	3
Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	ASD-STAN	prEN 4709-002	• external consultation • Version (date): December 2020 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems • DRI system for UA of the open Category • Compliant with draft U-space regulations: **Not completely, only DRI (no NIS)**	8
UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	ISO 23629-8	• Planning • Version (date): June 2020 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: Maybe /partially (based on the limited information presented in the outline)	-2

3.3 Gap summary

Table 5

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering: the limitation to direct remote identification leaves air traffic control and authorities without a situational awareness of drones flying around in their area of responsibility	The lack of a standardisation of UTM communication services and to compose an overall drone traffic information platform for authorities might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.

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Gap #	Gap Description	Conclusion Recommendation
		ISO 23629-12 is promising and satisfactory for the safety and quality of the related service providers, but additional technical standards may be necessary.

3.4 Conclusions & recommendations

More focus must be put on dynamic information during flight.

Table 6

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Exchange of drone tracking information over NIS on any drone traffic in the Designated Operational Coverage (DOC)[5].	Not covered	/	No European standards are currently identified	The EU Commission Regulation (EU) 2020/1058 covers the requirements for the airborne function supporting Network Remote Identification, however standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).
Display of the drone tracking information in the DOC	Not covered		No European standards are currently identified	standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
				safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).
Exchange of drone tracking information between multiple USSPs, which cover different DOCs	Not covered		No European standards are currently identified	standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).

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4 Geo-awareness service ②

4.1 *Description*

The latest European U-space draft of 2020 (Commission implementing regulation on a regulatory framework for the U-space) states:

A geo-awareness (GAW) service shall be provided to UAS operators and shall consist of the following geo-awareness information made publicly available by the common information service provider:

- *information on the applicable operational conditions and airspace constraints within the designated U-space airspace;*
- *UAS geographical zones, relevant to the designated U-space airspace;*
- *dynamic airspace restrictions temporarily limiting the area within the designated U-space airspace where UAS operations can take place.*

U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, and shall include its time of update or a version number or a valid time, or both.

Each Member State can determine where they want to implement UAS geographical zones (referred in Article 15 of [8]). The MS are also empowered to determine which restrictions, conditions, administrative procedures or mandatory functionalities apply in these UAS geographical zones (so called "geozones").

The laudable efforts of individual EU MS on the matter, may ensure a high level of safety, but not necessarily a "uniform" level of civil aviation safety which is also in the principal objective of the EASA Basic Regulation [9].

Furthermore, this situation would neither facilitate, the free movement of goods and services in the internal aviation market, nor improve the competitiveness of the Union's aviation industry, which is also a political objective established by the Legislator in Art. 1(2)(b) of mentioned [9].

It is therefore an important recommended action to standardise at EU level conditions, limitations and administrative procedures to access UAS geozones to further promote drone operations under harmonised criteria in the internal market. MS would still be empowered to design and establish the geozones according to their needs. The standardised limitations, conditions and administrative procedures, could be established by EASA through one or more AMC to Art. 15 of [8], referring therein as appropriate to consensus-based standards produced by SDOs.

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Because the CISP is providing information on the UAS geozones in a digital format to the USSPs it is important that the USSP is parsing these restrictions correctly and providing this data in an unambiguous way to UAS operators. This data source originates from the CISP.

This service is not requiring data to be exchanged amongst U-space service providers. No need to establish Inter USSP-communication.

4.1.1 EUROCAE - ED-269: Minimum Operational Performance Standard for Geo-Fencing

This document contains Minimum Operational Performance Standards (MOPS) for the airborne Geofencing function of Unmanned Aircraft Systems. This standard specifies the minimum performance expected from this Geofencing function, without prescribing its design and implementation as far as possible.

Compliance with this standard is recommended as one means of assuring that the function will perform its intended sub-functions satisfactorily under all conditions normally encountered in routine aeronautical operation and will comply to the applicable regulations.

The UAS geographical zones in this standard are mentioned as 'UAS Geozone'.

Basically, the data model contains a few classes to define the geographical and temporal boundaries of the UAS geozone but also other information such as contact information of the designated authority and conditions defining the access to the UAS geozone.

Some of the most notable attributes in this model are 'restriction' and 'restriction-Condition'. Each UAS zone will have a restriction type:

- PROHIBITED,
- REQ_AUTHORISATION,
- CONDITIONAL or
- NO_RESTRICTION.

For each UAS geozone with the conditional restriction type, it is possible to indicate the conditions to access to the UAS zone through logical expression which should be interpreted by the UAS.

The following example is given in the standard publication:

- *The UAS is* ***PERMITTED XOR PROHIBITED*** *(exclusive choice) to fly in this zone at this time IF (Characteristic1)* ***CHARTYPE1*** *= (Value1)* ***CHARVAL1*** *AND* ***CHARTYPE 2 = CHARVAL 2*** *AND … AND End IF OR (…..)*
  …
  End OR
- Only the fields in bold need to be edited in the character string, separated by"/". Others are implicit.

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- Examples of CHARTYPE and CHARVALUE:
    - CHARTYPE: operator type ; Acceptable CHARVAL values: Military/Police/Firefighting
    - CHARTYPE: Operator ID (registration number) ; Acceptable CHARVAL values: as per registration format
    - CHARTYPE : Operation type : A1 as per EASA Open Types or S1 (National standard Scenario 1), STS01 (EASA Specific standard scenario) or …
    - CHARTYPE : UTM operation type: Planned/Unplanned,
    - CHARTYPE: passengers on board : yes /no
- Another code example to illustrate the prohibition of image capture in a zone: *PERMITTED/IMAGE CAPTURE=NO/NOISE CLASS=A/OR/OPERATOR=POLICE*
    - Meaning: the fight is permitted in this zone at that time if 'No image' are 'captured' (removed or deactivated) and if 'noise class' = 'class A' (following a known classification) or if the 'UAS operator' is the 'Police'

4.1.2 ASTM - WK63418: Standard for UAS Traffic Management (UTM) Service for Mixed Use Airspace Technical Interoperability & Protocols

The ASTM ToR-2020 for this standard uses the term 'Constraints' as method to inform operators of specific temporal and geographic limitations of the airspace.

It seems that the actual conditions to access the UAS geozone would not be included in the constraint. A constraint will only be defined by 4D volume (area specified in x, y and z coordinates, plus start and end times) and a constraint type.

According to the ASTM UTM standard, constraints are managed in the Constrain Management Service by authorized constraint provider (which is an organization or individual authorized by competent authority for the region to create constraints). After the creation of the constraint, it will be made discoverable through the Discovery and Synchronization Service. USS(P) ingest constraints through the Constraint Ingestion service to detect intersection between operational volume with constraint areas.

The ASTM standard is not (yet) compliant with the restrictions which are requested by 'Commission implementing regulation on a regulatory framework for the U-space': restrictions must be able to be added per UAS geographical zone.

In other words, while ED-269 complements the EU regulatory framework, 3.1.2. ASTM WK63418 seems tailored on the USA/FAA context.

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4.1.3 ISO - 23629-7: UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM

This standard specifies the data model that is related to various spatial information for common use between the UA operator and the system for operation control/UTM.

ISO is developing a very generic data model for all data within UTM. They are splitting the data model up in four packages, being:

- obstacles,
- ground map,
- virtual data
- and dynamic data.

4.1.4 ASD-STAN - prEN 4709-003: Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawareness

Developed for open category, focus on RPA and GCS, not on USS's.

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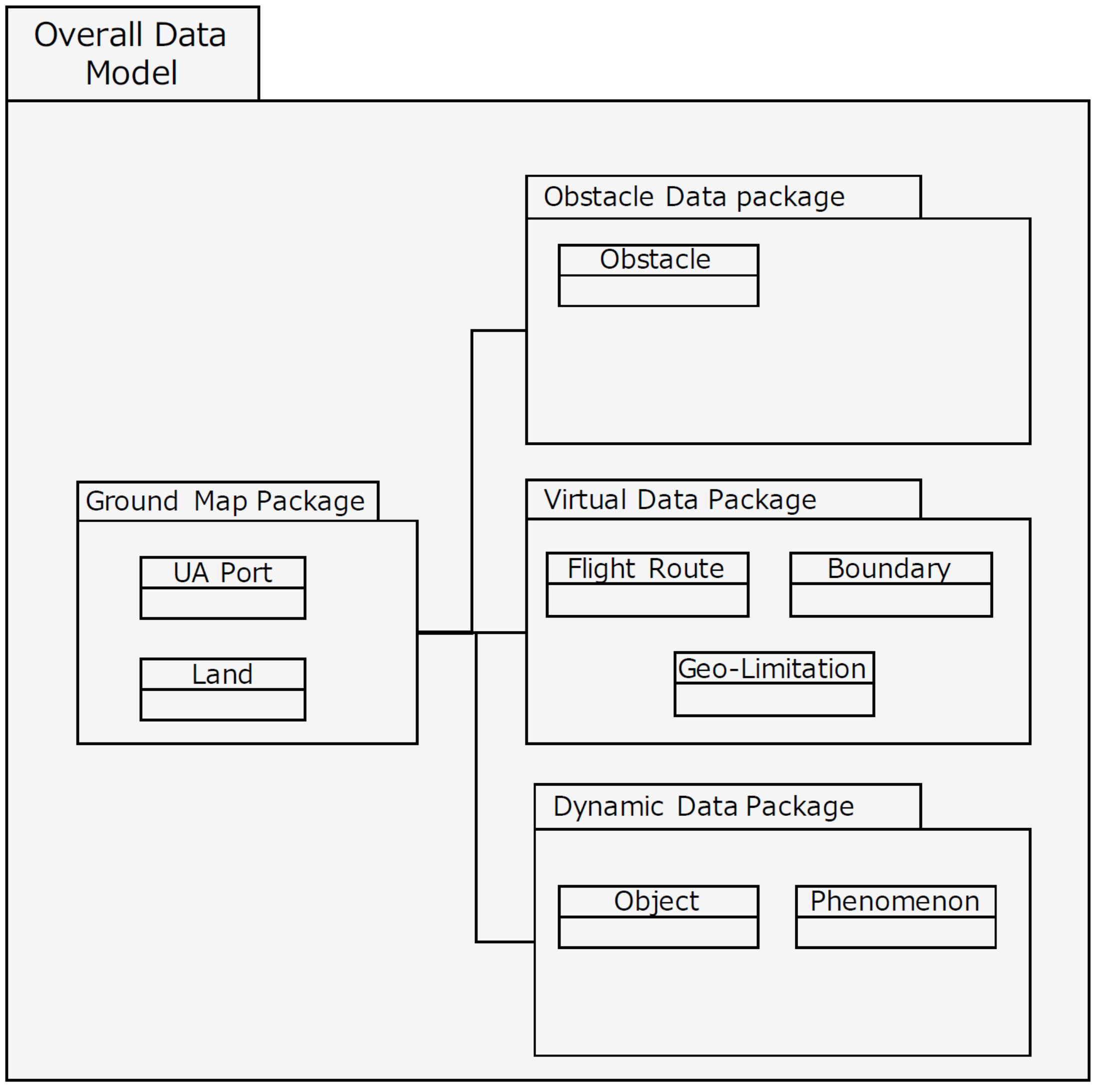

Figure 2 ISO 23629-7 model

Source: *ISO/WD 23629-7:(E) - UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM*

This standard, has just terminated the external consultation (DIS in ISO terminology) and might constitute the basic "open communication protocol" mentioned in the draft U-space regulation.

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4.2 *Summary*

Table 7

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Minimum Operational Performance Standard for Geo-Fencing	EUROCAE	ED-269	• Published • Version (date): June 2020 • Prep. by WG-105 SG-33 • Standardisation of UAS Geozones according the Implementing regulation • Compliant with draft U-space regulations: Yes	10
Standard for UAS Traffic Management (UTM) Service for Mixed Use Airspace Technical Interoperability & Protocols	ASTM	(WK63418)	• Ongoing: only ToR • Version (date): (unknown) • Prep. by WK63418 Task Group Name: • ASTM Collaborative Airspace Management Standards Working Group • Exchange of all UTM data according a federated deployment model. • Compliant with draft U-space regulations: No	-4
UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	DIS 23629-7	• External Consultation: Draft (DIS stage) • Version date: November 2020 • A very generic data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Yes, although not containing sufficient technical details, but complementary to more detailed ED-269.	7

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawarenes	ADS-STAN	prEN 4709-003	• Status: External consultation • Screened version: December 2020 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems • Functions for geoawareness implemented in UA or CU in the open Category • Conclusion: Compliant with draft U-space regulations: Not completely, since covering only functions at product level and not at service level. Furthermore, only applicable to open category	3

4.3 Gap summary

Table 8

Gap #	Gap Description	Conclusion Recommendation
1	No major gap identified using the complementary standards ED-269 and ISO 23639-7	No gaps to be filled.

4.4 Conclusions & recommendations

Table 9

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Information on the applicable operational conditions and airspace constraints within the designated U-space airspace;	partial	ED-269	Conditions are available as logical expression for each UAS geographical zone.	More general data model applicable beyond GAW

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
UAS geographical zones, relevant to the designated U-space airspace	partial	ED-269	The standard can be used to exchange information on UAS geo zones. The standard only contains U-space type and doesn't contain a reference of a specific U-space instance	
Dynamic airspace restrictions temporarily limiting the area within the designated U-space airspace where UAS operations can take place.	partial	ED-269	The standard is capable storing time validity period for a UAS geozone	
U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, and shall include its time of update together with a version number or a valid time, or both.	partial	ED-269	The standard can describe a version for a UAS zone and assign a time period to it.	
U-space service providers shall: (a) exchange any information that is relevant for the safe provision of U-space services amongst themselves; (b) adhere to an appropriate open	partial	ISO 23629-7	Generic data model to exchange all types of data in UTM. Scope covering all exchanges relevant in the U-space, but not sufficiently detailed.	It is complementary to more detailed ED-269

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
communication protocol …				

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5 Flight authorisation service ③

5.1 *Description*

The Flight Authorisation(or Clearance) Service (FCS) is very extensive comprising a lot underlying services and is described as follows in the U-space draft regulation:

1. The U-space service providers shall provide UAS operators with the UAS flight authorisation for each individual flight, setting the terms and conditions of that flight, through a UAS flight authorisation service, which is more or less equivalent to the acceptance of the Flight Plan in traditional manned aviation.
2. Where U-space service providers receive from the UAS operator an UAS flight authorisation request (similar to application for a Flight Plan but in a different format), they shall:
   (a) check if the UAS flight authorisation request is complete and correct and submitted in the form set out in Annex IV;
   (b) accept the UAS flight authorisation request if the flight under the UAS flight authorisation is free of intersection in space and time with any other notified flight authorisations within the same U-space airspace in accordance with the priority rules set out in paragraph 8 (which goes beyond the traditional process for accepting a flight plan);
   (c) notify the UAS operator about acceptance or rejection of the UAS flight authorisation request (this notification is simultaneously the acceptance of the plan and the clearance to take-off);
   (d) when notifying the UAS operator about the acceptance of the UAS flight authorisation request, indicate the allowed flight authorisation deviation thresholds.
3. When issuing a flight authorisation, the U-space service providers shall use, where applicable, weather information provided by the weather information service (WIS) as referred to in Article 12.
4. Where U-space service providers are unable to grant an UAS flight authorisation in accordance with the UAS operator’s request, U-space service providers may propose an alternative UAS flight authorisation to the UAS operator.
5. Upon receiving the request for an UAS flight authorisation activation referred to in Article 6(5), the U-space service providers shall confirm the activation of the UAS flight authorisation without unjustified delay.
6. U-space service providers shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different U-space services providers.

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7. U-space service providers shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.
8. When processing UAS flight authorisation requests, the U-space service providers shall apply the following priority rules in the following order:

    (a) UAS conducting special operations as referred to in Article 4 of Implementing Regulation (EU) No 923/2012 shall have priority over any other air traffic;

    (b) UAS carrying passengers shall have priority over UAS without passengers on board;

    (c) beyond visual line of sight (BVLOS) UAS operations shall have priority over visual line of sight (VLOS) UAS operations;

    (d) when two UAS flight authorisations requests have the same priority, they shall be processed on a first come first served basis.

9. U-space service providers shall continuously check existing flight authorisations against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic shared by relevant air traffic service units, in particular regarding manned aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, and update or withdraw authorisations as may be necessitated by the circumstances.
10. U-space service providers shall issue a unique authorisation number for each UAS flight authorisation. This number shall enable the identification of the authorised flight, the UAS operator and the U-space service provider issuing the UAS flight authorisation.

As currently described, the flight authorisation service encompasses a lot of underlying services and actions to be performed and as such is quite complex:

- Flight Plan/Authorisation Validation,
- Strategic deconfliction,
- Flight Plan Processing,
- Flight Plan Assistance
- and Priority Management.

Standards which have been assessed are the following:

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5.1.1 ASTM - WK63418: ASTM - New Specification for Service provided under UAS Traffic Management (UTM)

ASTM WK63418 and which has published Terms of Reference (TOR) suggesting a data exchange model between USSP's but is immature at this stage.

5.1.2 ISO - DIS 23629-7: Data model for spatial data

ISO/DIS 23629-7 has developing a very generic data model for spatial data; suggesting an attribute model to exchange data between the UAS and UTM operators.

5.1.3 ISO - CD 23629-9: Data model for spatial data

ISO TC/20 SC/16, in its WG 4 is planning as well 23629-9 on interfaces between users and several service providers, as depicted in the figure below.

However this standard is only in the planning stages and, in the absence of this or equivalent standard, it seems unlikely to safely and in a verifiable way, interface several providers of FCS in the same airspace volume.

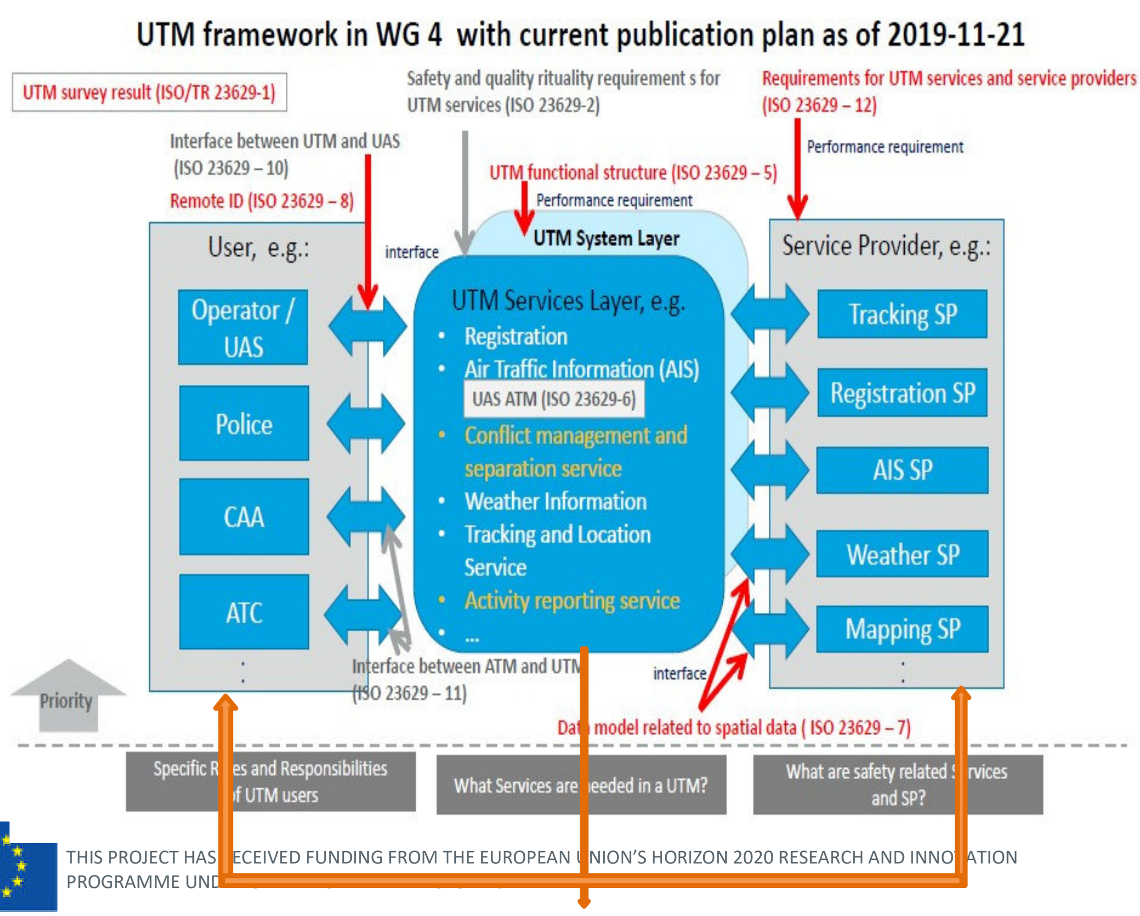

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Figure 3 ISO TC/20 SC/16 WG 4 UTM model

5.2 *Summary*

Table 10

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	WK63418	• Ongoing: planned • Version (date): February 8th 2019 • WK63418 • Exchange of all UTM data according a federated deployment model. • Compliant with draft U-space regulations: Maybe/partially (partly but currently premature)	-2
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • A very generic data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Partially; based on the deployment model this standard is not compliant with U-space, since not mentioning the possibility of several FCS providers.	7
Interface between UTM service providers and users	ISO	23629-9	• Planned: but the New Work Item Proposal (NWIP) is not even drafted. • Version date: November 2020 • Interface model to exchange all types of data among several UTM actors, including several Service Providers. • Compliant with draft U-space regulations: Yes, since covering the possibility of several FCS providers.	-2

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5.3 *Gap summary*

Table 11

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the interface among several FCS Providers	Until a standard on the interface would not be available, allowing several FCS Providers in the same DOC may not be sufficiently safe. ISO 23629-9 may fill the gap, but this standard is not even drafted.

5.4 *Conclusions & recommendations*

The Flight Authorisation Service as currently drafted in the U-space regulation encompasses a variety of individual services (e.g. strategic deconfliction, priority management, dynamic, authorisation management) and actions needed which are grouped together. This makes that in the future several standards will apply fully or partially to this services but also that currently no standard is ready to cope with the service. The standards or drafts assessed for this service were either in a premature fase (ASTM WK63418) or were applicable to this service but only covered a small, though important aspect. This is the case for standard (not yet published) ISO ISO/DIS 23629-7.

It is foreseeable that no single standard will cover the 'flight authorization service' but it will be impacted by multiple future standards.

Table 12

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. U-space SP shall provide UAS operators with flight authorisation for each individual flight, setting the terms and conditions of that flight	Covered	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	No gap
2. Upon receiving an UAS flight authorisation request USSP shall:	Partial	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	Data exchanges between UAS operator and USSP, including response from USSP to a

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
(a) check if request is complete and correct (b) accept the request if the intended flight is free of intersection in space and time with any other notified flight (c) notify UAS operator about acceptance or rejection (d) when accepting, indicate allowed flight authorisation deviation thresholds.			Related ISO 23629-12 covers safety and quality of the USSP, but it leaves details to provider's procedures or other standards not yet available.	flight authorisation request, possibly covered by ISO 23629-9, which is however only in the planning stage.
3. When issuing a flight authorisation, the USSP shall use, where applicable, weather information provided by WIS	Covered	ISO 23629-7	This standard covers the geospatial data, including "phenomena" and associated geographical position and time	No gaps
4. USSP may propose an alternative UAS flight authorisation to the UAS operator.	Covered	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	No gaps
5. Upon receiving the request, the USSP shall confirm the activation of the UAS flight authorisation without unjustified delay	Not covered	None	Maximum permissible times related to transaction, might be included in ISO 23629-9	Maximum permissible times for data exchanges between UAS operator and USSP, including response from USSP to a flight authorisation

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
				request, possibly covered by ISO 23629-9, which is however only in the planning stage.
6. USSPs shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different USSPs.	Not covered	ASTM - WK63418 Or ISO 23629-9	Both standards are in the planning stage.	Not even a preliminary draft of either candidate standard is available.
7. USSP shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.	Covered	ISO 23629-7	This standard covers the geospatial data, including attributes of the geo-limitations.	No gaps.
8. When processing UAS flight authorisation requests, the U-space service providers shall apply the following priority rules in the following order: …	Covered	ISO 23629-12	This requirement is of regulatory nature and does not require detailed technical standards. ISO 23629-12 covers safety and quality of all USSPs, including a monitoring functions to verify compliance of procedures with applicable regulations.	No gaps
9. USSP shall continuously check existing flight authorisations against new dynamic airspace restrictions and	Partial	ISO 23629-7	ISO 23629-7 contains a “dynamic data package”, but however limited to	The “dynamic data package” in ISO 23629-7 should be amended, to include also dynamic airspace

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
limitations, and information about manned aircraft traffic shared by relevant ATS units, and update or withdraw authorisations as may be necessitated by the circumstances.			aircraft and whether phenomena	restrictions and limitations.
10. USSP shall issue a unique authorisation number for each UAS flight authorisation.	Partial	ISO 23629-7	ISO 23629-7 contains a UAS "Object", including the flight identifier. However, how to encode this identifier is not specified therein.	The "UAS object" in ISO 23629-7 should be amended, to include standards to encode the flight identifier. Alternatively this should be covered by ISO 23629-9

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6 Traffic information service ④

6.1 *Description*

No standards for TIS tailored to the needs of UAS are currently identified, although for manned aviation TIS is covered by EUROCAE ED-102B, while service e provisions is covered by ISO 23629-12. Further investigation by SDO's of Asterix and AWCIES is advised as source or base to develop (similar) standards.

Standards can be identified as an AMC for a Traffic information service when covering following service requirements:

1. A traffic information service provided to the UAS operator shall contain information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.

2. The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.

3. The traffic information service shall provide information about the position of other known air traffic and shall:
   a. include latitude and longitude, altitude, time of report as well as speed, heading or direction and emergency status of aircraft, when known;
   b. be updated at a frequency that the competent authority has determined in accordance with Annex I.

4. Upon receiving the traffic information services from the U-space service provider, UAS operators shall take the relevant action to avoid any collision hazard.

6.1.1 EUROCAE - ED-102B: MOPS for ADS-B and TIS on 1090 MHz

This document contains Minimum Operations Performance Standards (MOPS) for airborne equipment for Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B).

6.1.2 ISO - DIS 23629-7: Data model for spatial data

Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope.

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6.1.3 ISO - 23629-9: Interface between UTM service providers and users

This document describes an interface model to exchange all types of data among several UTM actors, including flight objects (manned or unmanned).

6.1.4 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

Includes the requirements for Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users, and covers minimum safety, quality, security and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

In addition, it specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

6.2 *Summary*

Table 13

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for ADS-B and TIS on 1090 MHz	EUROCAE	ED-102B	• Published • Version date: December 2020 • Specification of avionics for ADS-B at 1090 MHz and receiving TIS-B at 1030 MHz, applicable to manned aviation • Compliant with draft U-space regulations: No, since covering the needs and frequencies related to manned aviation.	0

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • Contains data models for flight object, either if the aircraft is manned or unmanned. • Compliant with draft U-space regulations: Partially, since not containing sufficient technical details for implementation.	7
Interface between UTM service providers and users	ISO	23629-9	• Planned: but the New Work Item Proposal (NWIP) is not even drafted. • Version date: November 2020 • Interface model to exchange all types of data among several UTM actors, including flight objects (manned or unmanned). • Compliant with draft U-space regulations: Yes, since covering the possibility of several FCS providers.	-2
UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	• External consultation (CD stage) • Version: Stage 30.20 • It contains requirements for the safety and quality of the TIS SP • Compliant with draft U-space regulations: Partially, since technical details for TIS are not covered	3

6.3 *Gap summary*

Table 14

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the technical details for transmission of TIS information on a frequency different from 1030/1090 MHz or for exchange if data between USSP and UAS Command Unit (CU).:	Flight objects, necessary to exchange TIS information, are covered by ISO 23629-7. However, lack of a standardisation of communication means might compromise uniform safety. Standardisation would be

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Gap #	Gap Description	Conclusion Recommendation
	information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	beneficial for uniform safety and EU industry perspectives.
2	Information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	The lack of a standardisation of communication and to exchange information on TIS across several providers might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
3	Information about the position of other known air traffic	Content of the traffic information has been defined, standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspectives. The case that the TIS information is provided to the CU and not directly to the unmanned aircraft should be considered.

6.4 *Conclusions & recommendations*

The standards used for General Aviation must be further investigated. A potential problem is that USSP's will use different device requirements.

Table 15

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	Partial	ISO 23629-7 and ISO 23629-12	These standards cover the definition of the "flight object" (whether manned or unmanned), and the safety and quality of the TIS provider. However, they do not cover the communication means to exchange the TIS	Interface requirements are planned to be covered through ISO 23629-9

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
			information between the USSP and the UAS operator	
Include information about manned aircraft and UAS traffic shared by other USSPs and relevant ATS units.	/	/	No standards are currently identified	No requirements are currently covered by a potential AMC
Information about the position of other known air traffic	Covered	ISO DIS 23629-7	This standard contains definition of flight "objects", whether the aircraft is manned or not.	No gaps

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7 Weather information service ⑤

7.1 *Description*

ASTM has published a Terms of Reference (ToR) for the safety and quality of the WIS Provider. On the same matter, ISO 23629-12 is already in the external consultation phase (CD). Furthermore, ISO 23629-7 defines information on "phenomena". Based in this ToR a preliminary assessment has been conducted.

Standards can be identified as an AMC for a Weather information service when covering following service requirements:

1. When providing a weather information service, U-space service providers shall:
    a. collect weather data, provided by trusted sources, to maintain safety, supporting operational decisions of other U-space services;
    b. provide the UAS operator with weather forecasts and actual weather information either before or during the flight.

2. The weather information service shall include, as a minimum:
    a. wind direction measured clockwise through the true north and speed in metres per second, including gusts;
    b. the height of the lowest broken or overcast layer in hundreds of feet above ground level;
    c. visibility in metres and kilometres;
    d. temperature and dew point;
    e. indicators of convective activity and precipitation;
    f. QNH
    g. the location and time of the observation, or the valid times and locations of the forecast.

3. U-space service providers shall provide weather information that is up-to-date and reliable to support UAS operation.

7.1.1 ASTM - WK73142: New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.

Potentially suitable as all requirements are being referred to are being addressed. Only TOR available.

7.1.2 ISO - DIS 23629-7: Data model for spatial data

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Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope.

7.1.3 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

This standard includes the requirements for Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users.

This document covers minimum safety, quality, security and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

This document, in addition, specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

7.2 *Summary*

Table 16

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.	ASTM	(WK73142)	• Planning phase • Version (date): April 2020 • Only ToR available • A lack of meteorological information might hinder UAS operations and compromise safety • Good basis to full requirements as the requirements are being addressed in the ToR • Conclusion: ToR indicate a full coverage	-4

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • Contains data models for meteorological phenomena. • Compliant with draft U-space regulations: Partially, because only defining which information should be exchanged	7
UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	• External consultation (CD stage) • Version: Stage 30.20 • It contains requirements for the safety and quality of the WIS SP • Compliant with draft U-space regulations: Partially, but required WIS information is specified in ISO 23629-7	3

7.3 *Gap summary*

Table 17

Gap #	Gap Description	Conclusion Recommendation
1	Provision of weather data before and during the flight	A lack of meteorological information might hinder UAS operations and compromise safety. Further standards on interfaces between USSPs and UAS Operators should be developed. One possibility is ISO 23629-9, being planned by WG4 of ISO TC/20 SC/16
2	Content and format of weather data messages	No gaps identified
3	Safety and quality of weather information	No gaps identified at the level of consensus based standards, since ISO 23629-12 covers this topic.

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Gap #	Gap Description	Conclusion Recommendation
		However, a general AMC published by EASA and specifying under which conditions consensus-based industry standards may constitute presumption of compliance with the rules, is highly desirable. AMC to AIR-OPS already contain a similar AMC, which, for ease of reference is reproduced in Annex IV.

7.4 *Conclusions & recommendations*

More research on how to present the weather information to the operators must be done.

QNH will be added to the requirements list

Table 18

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Provision of weather data before and during the flight	Partial	ISO CD 23629-7	• Contains data models for meteorological phenomena. • Partially compliant with draft U-space regulations, because only defining which information should be exchanged, but not interfaces	236297 should be complemented by 235629-9 specifying the interfaces to exchange the information
Content and format of weather data messages	Covered	ISO CD 23629-7	• Contains data models for meteorological phenomena. •	No gaps identified
Safety and quality of weather information	Covered	ISO CD 23629-12	• Contains safety and quality requirements for all USSPs, including WIS	No gaps identified

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8 Conformance monitoring service ⑥

8.1 *Description*

Standards can be identified as an AMC for a Conformance monitoring service when covering following service requirements[4]:

1. A conformance monitoring service shall enable the UAS operators to verify whether they comply with the requirements set out in Article 6.1**(1)** and the terms of the flight authorisation. To this end, that service shall alert the UAS operator when the flight authorisation deviation thresholds are violated and when the requirements in Article 6.1**(1)** are not complied with.

2. Where the conformance monitoring service detects a deviation from the flight authorisation, the U-space service provider shall alert the other UAS operators operating in the vicinity of the UAS operators, other U-space service providers offering services in the same airspace, relevant air traffic services units and relevant authorities.

(1): 1. When operating in the U-space airspace, UAS operators shall:

- a. *ensure that the UAS to be operated in the U-space airspace have the capabilities and performance requirements determined in accordance with Article 3.4.a**(2)***
- b. *ensure that during their operations, the necessary U-space services referred to in Article 3.2 and 3.3**(3)** are used, and their requirements complied with;*
- c. *comply with the applicable operational conditions and airspace constraints referred to in Article 3.4.c**(4)***

(2): 4. For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I [4], Member States shall determine:

- a. *the UAS capabilities and performance requirements;*

(3): 3.2 All UAS operations in the U-space airspace shall be subject to at least the following mandatory U-space services:

- a. *the network identification service referred to in Article 8;*
- b. *the geo-awareness service referred to in Article 9;*
- c. *the UAS flight authorisation service referred to in Article 10;*
- d. *the traffic information service referred to in Article 11.*

3.3 For each U-space airspace, based on the airspace risk assessment MS may require additional U-space services selected from the services referred to in Articles 12 and 13.

(4): 3.4 For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I, Member States shall determine:

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c. the applicable operational conditions and airspace constraints.

This service aims to the conformance to the flight authorisation considering weather, height, waypoints, etc., so not relating directly to geocaging (no aerospace restrictions, but conformance to the flight authorisation).

Two standards have been identified:

8.1.1 EUROCAE - ED-270: MOPS for Geocaging

The standard is a Minimum Operational Performance Standard and this specifies the minimum performance expected for geocaging but does not prescribe design or implementation.

8.1.2 ASTM - F3442 / F3442M - 20: Standard Specification for Detect and Avoid System Performance Requirements

This standard describes detect and avoid (DAA), i.e. a subsystem within the UAS providing the situational awareness, alerting, and avoidance necessary to maintain safe BVLOS operation of the unmanned aircraft in the presence of other manned aircraft. It is not applicable to the avoidance of unmanned aircraft to manned aircraft.

This standard does not address conformance monitoring directly.

ASTM is working on conformance monitoring through WK63418 Standard Specification for UAS Service Supplier (USS) Interoperability.

8.2 *Summary*

Table 19

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for Geocaging	EUROCAE	ED-270	• Published • Version (date): June 2020 • MOPS for geocaging • Possible AMC, but lacks design or implementation details	4

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Standard Specification for Detect and Avoid System Performance Requirements	ASTM	F3442 / F3442M - 20	• Published • Version (date): November 2nd 2020 • Focus on DDA systems on board a UAS • Only partially compliant with U-space regulation: does not address conformance monitoring directly	2

8.3 *Gap summary*

Table 20

Gap #	Gap Description	Conclusion Recommendation
1	Identified standards lack full coverage and design and implementation details.	The EUROCAE ED-270 is focused on geo-caging and thus covers the requirements on a high level only, so it is recommended to detail the design and implementation. The lack of the latter might affect the efficiency of UAS operations and compromise safety.

8.4 *Conclusions & recommendations*

There is still a need for security standards for connections between CISP and USSP with reference to CMS (and other services).

Table 21

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. alert the UAS operator when the flight authorisation deviation	Partial	EUROCAE ED-270	• Only a Minimum Operational Performance Standard is available that remains to high level and only	Does not provide details on design or implementation.

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
thresholds are violated			focuses on geocaging.	
2. alert the other UAS operators operating in the vicinity of the UAS operators violating the deviation thresholds	Partial	EUROCAE ED-270	• Only a Minimum Operational Performance Standard is available that remains to high level and only focuses on geocaging.	Does not provide details on design or implementation.

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9 Annex I: Standards identified

9.1 *Standards per USS/Category*

Table 22 Standards per USS/Category

USS/Category	Standard title	SDO	Doc./WG Ref.
network identification service	UAS Remote ID and Tracking	ASTM	F3411-19
	MOPS for UAS E-Identification	EUROCAE	• ED-282 • Prepared by WG 105 (UAS) SG 32 (e-identifcation)
	UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	PWI 23629-8
geo-awareness service	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	EUROCAE	ED-269
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	ISD 23629-7
	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	(WK6341)
UAS flight authorisation service	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	(WK63418)
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model	ISO	ISO/DIS 23629-7

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USS/Category	Standard title	SDO	Doc./WG Ref.
	related to spatial data for UAS and UTM		
traffic information service	/		
weather Service	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	ASTM	(WK73142)
conformance monitoring sercvice	MOPS for Geocaging	EUROCAE	ED-270
	Standard Specification for Detect and Avoid System Performance Requirements	ASTM	F3442-20

9.2 *Standards per SDO*

Table 23 Standards per SDO

SDO	Standard title	Doc. Ref.	Comments
ASTM	UAS Remote ID and Tracking	F3411-19	Linked to: • Network Identification Serice
	New Specification for Service provided under UAS Traffic Management (UTM)	(WK6341)	Linked to: • Geo-awereness service
	New Specification for Service provided under UAS Traffic Management (UTM)	(WK63418)	Linked to: • Flight authorisation service • Communication service
	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	(WK73142)	Linked to: • Weather information service
	Standard Specification for Detect and Avoid System Performance Requirements	F3442-20	Linked to: • Conformance monitoring service

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SDO	Standard title	Doc. Ref.	Comments
EUROCAE	MOPS for UAS E-Identification	ED-282	Linked to: • Network Identification Serice
	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	ED-269	Linked to: • Geo-awareness service
	MOPS for Geocaging	ED-270	Linked to: • Conformance monitoring service
ISO	UAS traffic management (UTM) — Part 5: UTM functional structure	CD 23629-5	Linked to: • All services considered in this document
	UAS traffic management (UTM) — Part 7: Data model for spatial data	DIS 23629-7	Linked to: • All services considered in this document
	UAS Traffic Management (UTM) — Part 8: Remote identification	ISO 23629-8	Linked to: • Network Identification Service
	UAS traffic management (UTM) — Part 9: Requirements for interfaces between UAS operators and UTM SPs	ISO 23629-9	Linked to: • All services considered in this document
	UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	CD 23629-12	Linked to: • All services considered in this document
ASD-STAN	Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	prEN 4709-002	• Not applicable for U-space requirements: only DRI • specifies the messages listed, EXCEPT for the emergency status if the unmanned aircraft, this does

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SDO	Standard title	Doc. Ref.	Comments
			NOT apply for add-on devices

9.3 *Other standards and materials to be screened*

Table 24 Standards to be screened

SDO	Standard
ASTM	WK69690, Specification for Surveillance UTM Supplemental Data Service Provider Performance
IEEE	IEEE P1939.1, Standard for a Framework for Structuring Low Altitude Airspace for Unmanned Aerial Vehicle (UAV) Operations
IETF	Secure UAS Network RID and C2 Transport
JARUS	JARUS WG-6 UTM Subgroup (Annex H) is developing recommendations on roles and responsibilities of USP in the context of Safety Assessments of UAS Operations

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10 Annex II: Sources

[1]	EASA (2019, AMC & GM to Commission Implementing Regulation (EU) 2019-947 - Issue 1
[2]	AW-Drones (2020) D2.3: Methodology for the assessment of drone standards
[3]	Opinion No 01-2020 high level framework for the U-space
[4]	Draft Commission Implementing Regulation on a regulatory framework for the U-space
[5]	ISO Committee Draft (CD) 23629-12 UAS Traffic Management (UTM) — Part 12: Requirements for UTM Services and Service Providers
[6]	ISO CD 23629-5, UAS traffic management (UTM) — Part 5: UTM functional structure
[7]	Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
[8]	European Union (2019), Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, as lastly amended by Commission Regulation 2020/746.
[9]	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91
Web site	Eurocae (https://www.eurocae.net/)
Web site	ASTM (https://www.astm.org/COMMITTEE/F38.htm)
Web site	ISO https://www.iso.org/committee/5336224.html
Web site	FAA (https://www.faa.gov/uas/research_development/remote_id/industry/)

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Web site	Using Mobile Networks to Coordinate – Unmanned Aircraft Traffic – GSMA white paper (https://www.gsma.com/iot/wp-content/uploads/2018/11/Mobile-Networks-enabling-UTM-v5NG.pdf)

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11 Annex III: Maturity Correlation Table

Different SDOs use different terminology for the phases of respective development projects. A correlation table for their respective semantics is provided:

Table 25 Maturity correlation of standards

AW-Drones maturity	ORGANISATION					
	JARUS	ISO	CEN CENELEC	EUROCAE	ASTM	RTCA
Planning	Terms of Reference (ToR)	Stage 10 (New Work Item)	New Work Item	ToR	ToR	ToR
Drafting	Drafting	Stage 20 (Preparatory – WD)	Drafting (including through ASD-STAN)	Drafting (DP)	Drafting	Drafting
Internal consultation	Internal consultation	Stage 30 (Committee State – CD)	ASD-STAN consultation (prEN)	Peer review (ED)	Sub-Committee ballot	N.A.
External consultation	External consultation	Stage 40 & 50 (Enquiry & Approval stages – DIS & FDIS)	Enquiry (FprEN)	Open Consultation (ED)	Committee ballot	Final Review and Comment (FRAC)
Published	Published	Stage 60 (publication)	Published (EN)	Published (ED)	Publication	Publication (DO)
Recognised	**NA: JARUS deliverables are recommendations for regulation, not consensus-based industry standards to be recognised by EASA**	**Mentioned in at least one AMC or GM published by EASA (or proposed in an NPA)**				

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12 Annex IV: Generic EASA AMC to link rules to industry standards

The model could be the existing AMC to Part-ARO, related to EU Regulation 965/2012 (AIR-OPS)

AMC1 ARO.GEN.305(b);(c);(d);(d1) Oversight programme

INDUSTRY STANDARDS

(a) For organisations having demonstrated compliance with industry standards, the competent authority may adapt its oversight programme, in order to avoid duplication of specific audit items.
(b) Demonstrated compliance with industry standards should not be considered in isolation from the other elements to be considered for the competent authority's risk-based oversight.
(c) **In order to be able to credit any audits performed as part of certification in accordance with industry standards, the following should be considered**:

(1) the demonstration of compliance is based on certification auditing schemes providing for **independent and systematic verification**;
(2) the existence of an **accreditation scheme** and accreditation body for certification in accordance with the industry standards has been verified;
(3) certification audits are **relevant** to the requirements defined in Annex III (Part-ORO) and other Annexes to this Regulation as applicable;
(4) the scope of such certification audits can **easily be mapped** against the scope of oversight in accordance with Annex III (Part-ORO);
(5) **audit results are accessible to the competent authority** and open to exchange of information in accordance with Article 15(1) of Regulation (EC) No 216/2008; and
(6) the audit **planning intervals** of certification audits i.a.w. industry standards are compatible with the oversight planning cycle.

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13 Annex V: Standards' Assessment

1. U-space Standards' Assessment: https://seafile.dblue.it/f/06f462cc8640401d8e59/

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AW-Drones proposed standards – 2nd iteration (U-Space)

D4.2

AW-Drones

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AW-Drones

Abstract

The AW-Drones project aims at supporting the European drone regulatory framework by identifying consensus-based voluntary standards which are deemed suitable to support the UAS common European rules at the level of Acceptable Means of Compliance (AMC) in the perspective of the "Performance-Based Regulation".

The Performance-Based Regulation in fact postulates that AMC should be published in a large proportion not by Authorities, but by Standard Development Organisations (SDOs).

This document presents the results deriving from the assessment of standards, published or under advanced development by SDOs, considered potentially compliant to the requirements set in the Draft Commission Implementing Regulation on a regulatory framework for the U-space [3], including not only related airborne functions, but also service provision.

For each U-space service, this document provides a list of standards offering at least a partial coverage, identification of the gaps which prevent a complete coverage, and conclusions & recommendations to cover each gap for fully meeting the requirement.

The recommendations may be used by EASA to publish a list of AMC acceptable to the Agency, or by the European UAS Standard Coordination Group (EUSCG) where SDOs could discuss how to fill the gaps.

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Introduction

1.1 Standards' assessment in the context of AW-Drones

The lack of clear and clearly identified standards is holding back the development of the drone-related business, both at a global level and in Europe. Several studies and surveys identify a comprehensive regulatory and standardisation framework as a main potential booster for the drone business. Therefore, to foster the growth of a safe drone usage, there is a need to implement coherent and interoperable global standards compliant with the regulations for drones in the European Union. The EU's Horizon 2020 Research and Innovation Program funded Project AW-Drones to tackle these issues and guide future EU drone regulation, mainly at the level of so-called "soft rules". i.e. consensus-based voluntary standards produced by Standard Development Organisations (SDOs) for voluntary application supporting the Commission Regulations (legally binding "hard rules") at the level of Acceptable Means of Compliance (AMC).

The idea that regulatory material adopted by Authorities could be complemented by consensus-based standards emerged in civil aviation in 1998, through Resolution A32-14 adopted by the ICAO General Assembly. The concept in EU is often referred as "Performance-Based Regulation" meaning that EASA could enshrine standards published by SDOs at the level of AMC, instead of directly drafting such material.

AW-Drones contributes to supporting the European Union's drone "hard" regulations through identification of suitable standards, enabling safe, environmentally sound and reliable operations of non-military drones in the European Union.

In order to achieve this objective, one of the sub-goals of the project is to propose a well-reasoned set of technical standards for operations and for U-space services, appropriate for all relevant categories of drone operations.

A work plan has been formulated to collect and assess existing and planned standards. The effort is split into three main technical work packages (WP):

- WP2 - Development of a methodology for categorization and assessment
- WP3 - Collection and categorization of standards that might be applicable for UAS
- WP4 - Assessment of these standards to evaluate their feasibility to support this process in order to derive a set of standards that are validated and found applicable.

While the first activity was carried out only at the beginning of the project to set the ground for all the subsequent work, both the data collection and the assessment of the standards is carried out iteratively over the course of the three years of the project. In particular during the first year (2019) the project focused on the collection and assessment of standards potentially suitable to support the demonstration of compliance to the criteria in the Specific Operations Risk Assessment methodology (SORA), which was released in deliverable D4.1.

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The SORA methodology, developed by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) is officially transposed in the EU regulatory framework by EASA as Acceptable Means of Compliance (AMC) No.1 to Article 11 of EU Regulation 2019/947 [1].

This deliverable D4.2 instead focuses on assessment of standards deemed suitable to support verification of conformity of identified U-Space services and related airborne functions.

With reference to deliverable D2.3 of the project [2], it was, by lack of AMC's, agreed with EASA to identify and assess with priority standards for the two services that are planned to be operational shortly: the Network Identification Service (NIS) and the Geo-Awareness Service (GAW). Even more specifically, the identified and assessed standards are aimed mainly to cover the aspects from a U-space service provider point of view.

However, this first version already contains all the potential U-space services presently known, and lists standards identified as a possible AMC. Some of these standards are still under development, while additional standards may emerge in the near future.

Therefore, the third iteration of AW-Drones will hand upcoming updates in the next issue of this document.

EASA is working on AMC guidance material (GM):

- work conducted in the AW-Drones project will be used for EASA's development on AMC GM
- divided in WP's (6 out of them (15) ref. to USS's)
- AMC GM expected to be ready by the end of October
- The AMC GM task force is currently working on NIS, GAS and FAS

1.2 Purpose and scope of this document

Based mainly on EASA Opinion No 01-2020 [3] on the high-level framework for the U-space and the draft of the Commission Implementing Regulation on a regulatory framework for the U-space [4], an architecture has been taken as a starting point for collecting standards related the mandatory U-space services, supporting services and related services.

The assessments are based on the methodology already defined in work package (WP) 2. This document contains the summary of the identified standards for each U-space service, a gap assessment as well as conclusions and recommendations. The assessments of the individual standards are contained in a separate tool, based on the aforementioned methodology.

1.3 Structure of the document

The structure of this document is based on the U-space services. For each service, there is a separate chapter including a description of the service and the identified standards, a summary,

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gaps identified and conclusions & recommendations. The assessments themselves are done in a separate Excel file: 'AW-Drones_D4.2_Annex_U-Space_Standards assessment.xlsx' [Annex V].

In chapter 2 some background information is given on U-space, as well as a schematic presentation of the U-space architecture used in the project, based on the already mentioned publications (sources [2] & [3]).

Chapter 3 to 8 addresses the U-space services, chapter 9 covers additional services and interfaces.

Annex I presents the identified standards per USS/Category and per SDO. It also presents a table suggesting standards and publications to be screened on potentially being suitable to cover U-space requirements

1.4 How to read this document

This section includes the used abbreviations and highlights the main features of the tables describing the assessment the standards. It explains how the information is presented and how to effectively read the results presented.

1.4.1 List of acronyms

AMC	Acceptable Means of Compliance
ASTM	American Society for Testing and Materials International
ATM	Air Traffic Management
CD	Committee Draft
CMS	Conformance Monitoring Service
CU	Command Unit
DOC	Designated Operational Coverage
DRI	Direct Remote Identification
GAW	Geo-Awareness service
NIS	Network Identification Service
EASA	European Union Aviation Safety Agency
EDPS	European Data Protection Supervisor

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FCS	Flight Clearance (alias authorisation) service
MOPS	Minimum Operational Performance Specification
MS	Member States
SDO	Standard Development Organization
EU	European Union
SORA	Specific Operations Risk Assessment
TIS	Traffic Information Service
TRS	Tracking Service
UAS	Unmanned Aircraft System
UCS	UTM Communication Service
USSP	U-space (alias UTM) service provider
UTM	UAS Traffic Management (equivalent to U-space)
WIS	Weather Information Service
WP	Work Package

1.4.2 Summary table

The summary table in each chapter includes the identified standards that could be considered by EASA as candidates to be published by the Agency as possible AMCs for the U-space services. Such tables include following columns:

Table 1 Example of Summary Table

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score

Standard title

The title of the document assessed, which can be a in a Planning, Drafting, Internal Consultation, External Consultation or Published phase. Please note different maturity terminologies are used amongst different SDO's, therefor a Maturity Correlation Table is provided in Annex III.

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SDO

The Standard Design Organisation (alias standard making body) which has published or which is producing the standard.

Doc. Ref.

The respective document reference

Status, scope & compatibility

Contains more info on the status of the document (Planning, Drafting, Internal Consultation, External Consultation, or Published), the scope of the document that matches the U-space service, and if this standards doesn't, partially of fully covers requirements. It might also contain the name of the working group.

Since different SDOs use different semantics to identify stages of respective developments, a correlation table is provided in Annex III.

Global score

This column presents a global score obtained by assessing each standard according to the methodology described in [2].

1.4.3 Gap summary

The gap summary table highlights the identified gaps missing to cover the requirements for the specific U-space requirement. The columns are divided as follows:

Table 2 Example of Gaps' Summary table

Gap #	Gap Description	Conclusion Recommendation

Gaps and Gap Description

Provides a number for each gap identified, explaining the nature of the gap and its rationale. The gaps listed in this table are generally not the same identified in the assessment of the individual standards, but rather gaps to fully cover the U-space service requirement, taking in consideration all currently available standards.

Conclusions and Recommendations

It provides conclusions on gaps which have been identified, with recommendations in relation to the severity of each respective score.

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In the framework of identifying gaps related to U-space service requirements, no quantitative assessments of the consequences of the gaps has been carried out.

1.4.4 Conclusions & recommendations

This section gives an overview of the current coverage of each requirement identified for the specific U-space service, providing a table with the best identified standards that cover the requirement at present, alongside any associated limitations and gaps.

Table 3 Example of Conclusions table

Requirement	Coverage	Recommended standards	Limitations/notes	Gaps

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2 Background information

2.1 U-space Services

AW-Drones considered only the 7 U-space Services listed in Chapter IV (U-space services) of Opinion No 01-2020 high level framework for the U-space [3] and related Draft Commission Implementing Regulation on a regulatory framework for the U-space [4] during the project. The current draft of the latter in fact specifies the following 6 services:

1. **Network identification service (NIS)**
    a. A network identification service should provide the identity of UAS operators and location of UAS during operations and in contingency situations, and share relevant information with other U-space airspace users.

2. **Geo-awareness service (GAW)**
    a. A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services.

3. **(UAS) flight authorisation service (alias Flight Clearance Service – FCS)**
    a. A flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified flight authorisations within the same U-space airspace.

4. **Traffic information service (TIS)**
    a. A traffic information service should alert UAS operators about other air traffic that may be present in proximity to their UAS.

5. **Weather information service (WIS)**
    a. A weather information service should support the UAS operator during the flight planning and execution phases, as well as improve the performances of other U-space services provided in the U-space airspace.

6. **Conformance monitoring service (CMS)**
    a. A conformance monitoring service should provide real-time alerting of non-conformance with the granted flight authorisation and inform the UAS operators when deviating from it.

It could be noticed that these listed 6 U-space services are all mentioned in draft ISO CD 23629-12 [5]; but the latter, based on CORUS, identifies more than 25 UTM services, categories into "safety-critical", "safety-related" and "operation support".

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2.2 U-space architecture

EASA and the Commission defined that the architecture needed for a successful implementation of U-space would be one with two types of service providers, being the 'Common Information Service Providers' and the 'U-space Service Providers'.

Further details on the possible U-space architecture are contained in [6].

Common Information Service Provider (CISP)

A Common Information Service Provider will be designated by Member States for every U-space airspace, as a single trustworthy source of reference information for the given U-space airspace for authorities, service providers and operators to enable the safe management of UAS operations. The CISP will support the exchange of information and the coordination between U-space service providers and air traffic service providers, without discrimination, to enable the safe management of unmanned aircraft traffic and segregation of manned aircraft from unmanned aircraft in the U space airspace under his jurisdiction.

A single standard of data will be needed:

- standard to be identified by EASA, currently left to the MS
- an open communication protocol standard is requested by EASA
- SWIM & Asterix to be further investigated

U-space service providers (USSP)

U-space service providers will act as gateway to U-space for Unmanned Aircraft Operators, they will provide the following minimum mandatory U-space services:

- Network Identification Service (safety-related in [5])
- Geo-awareness Service (safety-critical in [5])
- UAS Flight Authorisation Service (safety-critical in [5])
- Traffic Information Service (safety-critical in [5])

Mandatory vs supporting services

Next to the mandatory services above, following services are seen as supporting services but may be obligatory if deemed necessary by a Member State (MS):

- Weather Service (safety-related in [5])
- Conformance monitoring service (safety-critical in [5])

Related services

The following additional services may be offered as a service by the USSP or other authorised entity:

- ATM-CISP Interface

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- UTM Communication service (UCS) (safety-related in [5])

Unmanned aircraft operators may only operate in U-space airspace if they use the mandatory U-space services that are indispensable to ensure safe, secure, and efficient operations.

Note: in the Opinion No 01-2020 - high level framework for the U-space [3] 'tracking' service (TRS) was proposed as a U-space service, this however is currently not mentioned in the Draft Commission Implementing Regulation on a regulatory framework for the U-space [4]. In any case TRS is listed as safety critical service in [5].

Definition

No formal UTM (alias U-space) definition is yet published either by ICAO, EC or EASA. In this document the following definition from [5] is hence used:

UAS Traffic Management (UTM) Set of traffic management and air navigation services aiming at safe, secure and efficient integration of multiple manned and unmanned aircraft flying inside the respective DOC of each service. Note 1 to entry The definition is adapted from the ICAO Common UTM Framework with Core Principles for Global Harmonisation, 2nd edition, Nov. 2019 Note 2 to entry: In compliance with ICAO, Global Air Traffic Management Operational Concept, Doc 9854, 1st edition, 2005, UTM services initiate when the UAS operator files a request for clearance to enter airspace and terminates when the UA reaches the parking position, the primary propulsion systems are switched off and the operational plan is closed.

Architecture

The architectural diagram below is based both the before mentioned Opinion No 01-2020 - high level framework for the U-space [3] and the Draft Commission Implementing Regulation on a regulatory framework for the U-space [4].

The services which will be provided by the USSP are mentioned and described in the following chapters. The services/data which are mentioned in the architecture in the CISP system are interpreted as required to be provided by the CISP.

The architectural diagram displays the information flows. The services and flows are displayed as in the legend below. Optional/supporting services are dependent per Member State (MS).

The following legend is used:

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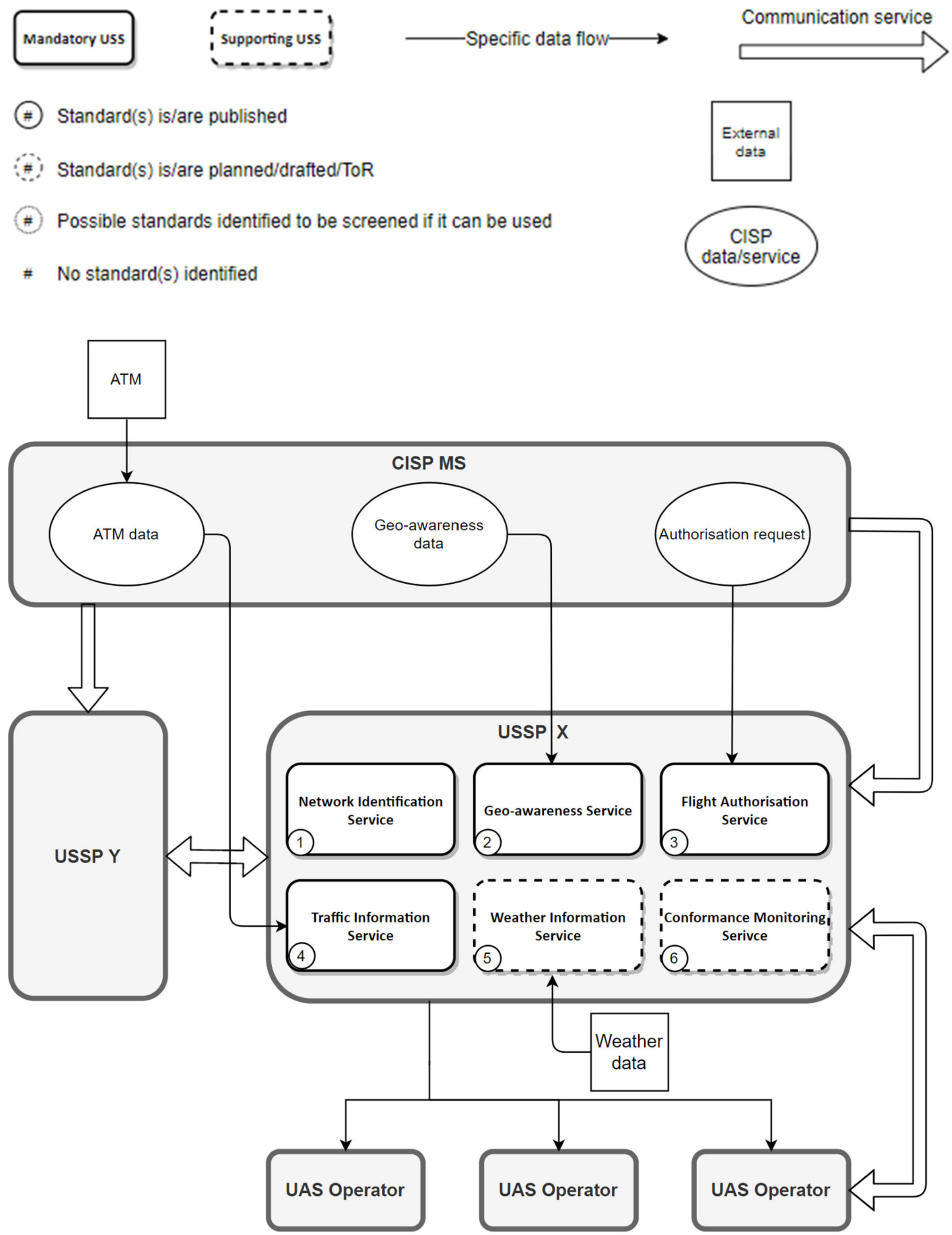

Figure 1 U-space architecture

The numbers shown in the diagram are also shown next to each chapter title for reference.

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3 Network identification service ①

3.1 Description

The detailed description of this service, according the 2020 draft U-space regulation, is:

A network identification service shall allow the continuous processing of the remote identification of the UAS throughout the whole duration of the flight and shall provide the remote identification of the UAS to authorised users in an aggregated manner.

The network identification service shall allow that the authorised users receive the messages with the following content:

a) The UAS operator registration number.
b) The unique serial number of the UA (or exclusively the Add-on) compliant with standard ANSI/CTA-2063-A-2019.
c) The time stamp, the geographical position of the UA and its height above the ground or its take-off point.
d) The route course measured clockwise from true north and ground speed of the UA.
e) The geographical position of the remote pilot, or if not available, the geographical position of the take-off point.
f) The UAS emergency status for Class C1, C2, C3. Not required for Add-on

The authorised users shall be:

- the general public as regards information that is deemed public in accordance with applicable Union and national rules;
  - Note: General public will have access to DRI, but not to NIS (see 1.2.3)
- other U-space service providers in order to ensure safety of operations in the U-space airspace;
- the air traffic services providers concerned;
- the competent authorities.

3.1.1 Network Identification Service (NIS) vs Direct Remote Identification (DRI)

The Implementing Regulation (EU) 2019/947 defines Direct Remote Identification (DRI) as a requirement for an airborne function in the Open Category. The network identification service requirements, in case a drone in either class C1, C2 or C3 would be equipped with such function, are included in Commission Regulation (EU) 2020/1058 . The difference between direct remote identification and network identification is described below.

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Direct remote identification means a system that ensures the local broadcast of information about an unmanned aircraft in operation, including the marking of the unmanned aircraft, so that this information can be obtained without physical access to the unmanned aircraft.

Direct remote identification is a method where the UAS is broadcasting the identification information which should be able to be received by mainstream smartphones.

Network Identification Service is a service where identification information is transmitted to the USSP through infrastructure such as LTE or satellite, managed by a provider of UTM Communication Service (UCS) where the identification and position information is continuously exchanged between service providers, if authorised.

Note: in the ASD STAN the terminology used for NIS is NRI (Network remote Identification), while in [5] it is NIS.

Neither DRI nor NIS are necessary to ensure airworthiness of the drone. In fact, DRI is necessary for enforcement, security and privacy considerations. Conversely NIS may be an operational requirement stemming form the airspace access rules.

3.1.2 **Readiness of the mobile network to communication in U-space**

The existing mobile networks can be reused without the need to deploy dedicated infrastructure for coverage in the air but limited in altitude due to antenna's directed towards the ground. In future deployments of 5G infrastructure the antenna pointing could be improved to allow NIS at higher altitudes. 3GPP standards are defined to provide global interoperable and secure connectivity. At present, mobile networks have sufficient capabilities to deliver connectivity, real-time data, security, and identity management for supporting U-space requirements. As mobile operators maintain and upgrade their existing infrastructure to 5G, their networks' capabilities will expand further.

There are concerns when using existing infrastructure in combination with the current LTE connectivity. Having too many drones in the air connected to the same pylon may decrease connectivity for all mobile users.

In any case [5] already contains safety and quality requirements for the related UCS providers, being this service considered safety-related by current ISO draft. Conformity with the applicable requirements could hence be verified through industry mechanisms, without involvement of the aviation authorities.

3.1.3 **ASTM - F3411 – 19: UAS Remote ID and Tracking**

During operation of the UAS, a Unique Operator's ID, (and possibly other codes, like e.g. the drone serial number) along with location and vector (speed/direction) will be communicated at a regular interval such that a compliant receiver will be able to identify an aircraft that is

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within operating range of the receiver for broadcast mechanisms and network range for network mechanisms.

Remote ID allows public and civil (i.e., government law enforcement agencies and private citizens) identification of UAS for safety, security, and compliance purposes, including for security and privacy purposes. The objective is to increase UAS operator accountability by removing anonymity while preserving operational and personal privacy for remote pilots, businesses, and their customers (with the European GDPR regulation [7] in mind).

This standard defines message formats, transmission methods, and minimum performance standards for two forms of Remote ID: broadcast and network. Broadcast Remote ID is based on the transmission of radio signals directly from a UAS to receivers in the UAS's vicinity. Network Remote ID is based on obtaining UAS remote identification information via the internet from a Network Remote ID Service Provider (Net-RID SP) that interfaces directly or indirectly with the UAS, or with other sources in the case of Non- Equipped Network Participants.

The term Broadcast Remote ID in this standard is equivalent to DRI in Commission Delegated Regulation 2019/945.

This standard is partially suitable to support the EU U-space draft Regulation, but gaps are being addressed in ASTM's current revision.

As NIS is currently not needed in FAA regulation, ASTM is working with Eurocae to address a global standard for NIS.

3.1.4 EUROCAE - ED-282: MOPS for UAS E-Identification

EUROCAE is developing ED-282 in coordination with ASD-STAN D05/WG08 for DRI. The "Open" (alias external) consultation on this standard was closed in August 2020. At beginning of 2021 EUROCAE is disposing the received comments to prepare the ED for publication.

Draft ED-282 'Minimum Operational Performance Standard for UAS E-Identification' specifies the minimum performance expected from e-Identification solutions for UAS and focuses on the E-Identification function meant to provide surveillance information generated by the UAS itself or its remote pilot station (RPS).

It does neither contrast ASTM F3411-19 nor prEN 4709-002, but the ED focuses on the network segment enabling the TRS.

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3.1.5 ASD-STAN - prEN 4709-002: Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification

This standard is defined in coordination with EUROCAE WG-105 SG-32 'UTM E-Identification' and ASTM. This standard was under "Enquiry" (i.e. external consultation) by CEN until 25 February 2021 and has a focus on Direct Remote Identification, which is a requirement in the implementing regulation for the open category.

Current outstanding challenges: in the delegated act it is specified that all information for DRI must protect the identification of the user.

The EDPS recommends that the Commission encourages RPAS manufacturers to implement privacy by design and by default and data controllers to carry out data protection impact assessments where processing operations present specific risks to the rights and freedoms of data subjects (i.e. citizens) by virtue of their nature, scope or purposes. As a consequence, the CEN prEN4709-002 standard does not cover the Remote Pilot/Operator privacy and data protection by design, and by default.

3.1.6 ISO - 23629-8: Remote identification

ISO started the development of an international standard on Remote ID. having approved the New Work Item Proposal (NWIP) on 22 June 2020. However, currently only the outline is available.

3.2 Summary

Table 4

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
UAS Remote ID and Tracking	ASTM	F3411-19	• Published • Version (date): February 28th 2020 • Prep. by WK65041 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: partially, but gaps are being addressed in ASTM's current revision.	16

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for UAS E-Identification	EUROCAE	ED-282	• External consultation • Version (date): June 2020 • Prep. by WG-105 SG-32 • NIS + DRI • Compliant with draft U-space regulations: yes, but demanding and thus expensive requirements	3
Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	ASD-STAN	prEN 4709-002	• external consultation • Version (date): December 2020 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems • DRI system for UA of the open Category • Compliant with draft U-space regulations: **Not completely, only DRI (no NIS)**	8
UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	ISO 23629-8	• Planning • Version (date): June 2020 • Broadcast (BLE or Wifi) • Network (between USS) • Compliant with draft U-space regulations: Maybe /partially (based on the limited information presented in the outline)	-2

3.3 Gap summary

Table 5

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering: the limitation to direct remote identification leaves air traffic control and authorities without a situational awareness of drones flying around in their area of responsibility	The lack of a standardisation of UTM communication services and to compose an overall drone traffic information platform for authorities might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.

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Gap #	Gap Description	Conclusion Recommendation
		ISO 23629-12 is promising and satisfactory for the safety and quality of the related service providers, but additional technical standards may be necessary.

3.4 Conclusions & recommendations

More focus must be put on dynamic information during flight.

Table 6

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Exchange of drone tracking information over NIS on any drone traffic in the Designated Operational Coverage (DOC)[5].	Not covered	/	No European standards are currently identified	The EU Commission Regulation (EU) 2020/1058 covers the requirements for the airborne function supporting Network Remote Identification, however standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).
Display of the drone tracking information in the DOC	Not covered		No European standards are currently identified	standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
				safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).
Exchange of drone tracking information between multiple USSPs, which cover different DOCs	Not covered		No European standards are currently identified	standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (planning phase).

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4 Geo-awareness service ②

4.1 *Description*

The latest European U-space draft of 2020 (Commission implementing regulation on a regulatory framework for the U-space) states:

A geo-awareness (GAW) service shall be provided to UAS operators and shall consist of the following geo-awareness information made publicly available by the common information service provider:

- *information on the applicable operational conditions and airspace constraints within the designated U-space airspace;*
- *UAS geographical zones, relevant to the designated U-space airspace;*
- *dynamic airspace restrictions temporarily limiting the area within the designated U-space airspace where UAS operations can take place.*

U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, and shall include its time of update or a version number or a valid time, or both.

Each Member State can determine where they want to implement UAS geographical zones (referred in Article 15 of [8]). The MS are also empowered to determine which restrictions, conditions, administrative procedures or mandatory functionalities apply in these UAS geographical zones (so called “geozones”).

The laudable efforts of individual EU MS on the matter, may ensure a high level of safety, but not necessarily a “uniform” level of civil aviation safety which is also in the principal objective of the EASA Basic Regulation [9].

Furthermore, this situation would neither facilitate, the free movement of goods and services in the internal aviation market, nor improve the competitiveness of the Union's aviation industry, which is also a political objective established by the Legislator in Art. 1(2)(b) of mentioned [9].

It is therefore an important recommended action to standardise at EU level conditions, limitations and administrative procedures to access UAS geozones to further promote drone operations under harmonised criteria in the internal market. MS would still be empowered to design and establish the geozones according to their needs. The standardised limitations, conditions and administrative procedures, could be established by EASA through one or more AMC to Art. 15 of [8], referring therein as appropriate to consensus-based standards produced by SDOs.

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Because the CISP is providing information on the UAS geozones in a digital format to the USSPs it is important that the USSP is parsing these restrictions correctly and providing this data in an unambiguous way to UAS operators. This data source originates from the CISP.

This service is not requiring data to be exchanged amongst U-space service providers. No need to establish Inter USSP-communication.

4.1.1 EUROCAE - ED-269: Minimum Operational Performance Standard for Geo-Fencing

This document contains Minimum Operational Performance Standards (MOPS) for the airborne Geofencing function of Unmanned Aircraft Systems. This standard specifies the minimum performance expected from this Geofencing function, without prescribing its design and implementation as far as possible.

Compliance with this standard is recommended as one means of assuring that the function will perform its intended sub-functions satisfactorily under all conditions normally encountered in routine aeronautical operation and will comply to the applicable regulations.

The UAS geographical zones in this standard are mentioned as 'UAS Geozone'.

Basically, the data model contains a few classes to define the geographical and temporal boundaries of the UAS geozone but also other information such as contact information of the designated authority and conditions defining the access to the UAS geozone.

Some of the most notable attributes in this model are 'restriction' and 'restriction-Condition'. Each UAS zone will have a restriction type:

- PROHIBITED,
- REQ_AUTHORISATION,
- CONDITIONAL or
- NO_RESTRICTION.

For each UAS geozone with the conditional restriction type, it is possible to indicate the conditions to access to the UAS zone through logical expression which should be interpreted by the UAS.

The following example is given in the standard publication:

- *The UAS is **PERMITTED XOR PROHIBITED** (exclusive choice) to fly in this zone at this time IF (Characteristic1) **CHARTYPE1** = (Value1) **CHARVAL1** AND **CHARTYPE 2 = CHARVAL 2** AND … AND End IF OR (…..)*
  …
  End OR
- Only the fields in bold need to be edited in the character string, separated by"/". Others are implicit.

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- Examples of CHARTYPE and CHARVALUE:
  - CHARTYPE: operator type ; Acceptable CHARVAL values: Military/Police/Firefighting
  - CHARTYPE: Operator ID (registration number) ; Acceptable CHARVAL values: as per registration format
  - CHARTYPE : Operation type : A1 as per EASA Open Types or S1 (National standard Scenario 1), STS01 (EASA Specific standard scenario) or …
  - CHARTYPE : UTM operation type: Planned/Unplanned,
  - CHARTYPE: passengers on board : yes /no
- Another code example to illustrate the prohibition of image capture in a zone: *PERMITTED/IMAGE CAPTURE=NO/NOISE CLASS=A/OR/OPERATOR=POLICE*
  - Meaning: the fight is permitted in this zone at that time if 'No image' are 'captured' (removed or deactivated) and if 'noise class' = 'class A' (following a known classification) or if the 'UAS operator' is the 'Police'

4.1.2 ASTM - WK63418: Standard for UAS Traffic Management (UTM) Service for Mixed Use Airspace Technical Interoperability & Protocols

The ASTM ToR-2020 for this standard uses the term 'Constraints' as method to inform operators of specific temporal and geographic limitations of the airspace.

It seems that the actual conditions to access the UAS geozone would not be included in the constraint. A constraint will only be defined by 4D volume (area specified in x, y and z coordinates, plus start and end times) and a constraint type.

According to the ASTM UTM standard, constraints are managed in the Constrain Management Service by authorized constraint provider (which is an organization or individual authorized by competent authority for the region to create constraints). After the creation of the constraint, it will be made discoverable through the Discovery and Synchronization Service. USS(P) ingest constraints through the Constraint Ingestion service to detect intersection between operational volume with constraint areas.

The ASTM standard is not (yet) compliant with the restrictions which are requested by 'Commission implementing regulation on a regulatory framework for the U-space': restrictions must be able to be added per UAS geographical zone.

In other words, while ED-269 complements the EU regulatory framework, 3.1.2. ASTM WK63418 seems tailored on the USA/FAA context.

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4.1.3 ISO - 23629-7: UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM

This standard specifies the data model that is related to various spatial information for common use between the UA operator and the system for operation control/UTM.

ISO is developing a very generic data model for all data within UTM. They are splitting the data model up in four packages, being:

- obstacles,
- ground map,
- virtual data
- and dynamic data.

4.1.4 ASD-STAN - prEN 4709-003: Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawareness

Developed for open category, focus on RPA and GCS, not on USS's.

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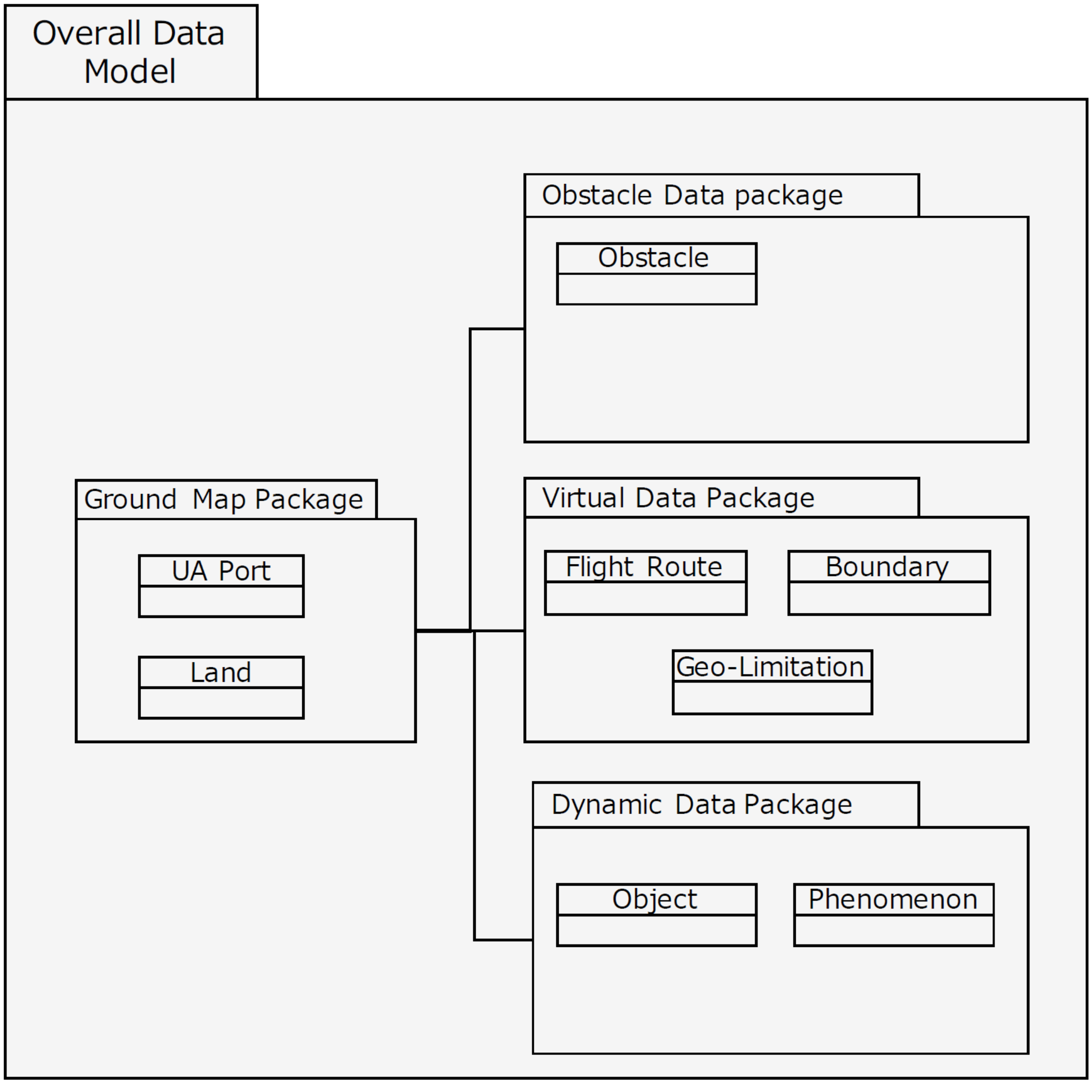

Figure 2 ISO 23629-7 model

Source: *ISO/WD 23629-7:(E) - UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM*

This standard, has just terminated the external consultation (DIS in ISO terminology) and might constitute the basic "open communication protocol" mentioned in the draft U-space regulation.

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4.2 *Summary*

Table 7

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Minimum Operational Performance Standard for Geo-Fencing	EUROCAE	ED-269	• Published • Version (date): June 2020 • Prep. by WG-105 SG-33 • Standardisation of UAS Geozones according the Implementing regulation • Compliant with draft U-space regulations: Yes	10
Standard for UAS Traffic Management (UTM) Service for Mixed Use Airspace Technical Interoperability & Protocols	ASTM	(WK63418)	• Ongoing: only ToR • Version (date): (unknown) • Prep. by WK63418 Task Group Name: • ASTM Collaborative Airspace Management Standards Working Group • Exchange of all UTM data according a federated deployment model. • Compliant with draft U-space regulations: No	-4
UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	DIS 23629-7	• External Consultation: Draft (DIS stage) • Version date: November 2020 • A very generic data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Yes, although not containing sufficient technical details, but complementary to more detailed ED-269.	7

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Aerospace series - Unmanned Aircraft Systems - Part 003: Geoawarenes	ADS-STAN	prEN 4709-003	• Status: External consultation • Screened version: December 2020 • Prep. by D05/WG08 UAS Unmanned Aircraft Systems • Functions for geoawareness implemented in UA or CU in the open Category • Conclusion: Compliant with draft U-space regulations: Not completely, since covering only functions at product level and not at service level. Furthermore, only applicable to open category	3

4.3 Gap summary

Table 8

Gap #	Gap Description	Conclusion Recommendation
1	No major gap identified using the complementary standards ED-269 and ISO 23639-7	No gaps to be filled.

4.4 Conclusions & recommendations

Table 9

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Information on the applicable operational conditions and airspace constraints within the designated U-space airspace;	partial	ED-269	Conditions are available as logical expression for each UAS geographical zone.	More general data model applicable beyond GAW

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
UAS geographical zones, relevant to the designated U-space airspace	partial	ED-269	The standard can be used to exchange information on UAS geo zones. The standard only contains U-space type and doesn't contain a reference of a specific U-space instance	
Dynamic airspace restrictions temporarily limiting the area within the designated U-space airspace where UAS operations can take place.	partial	ED-269	The standard is capable storing time validity period for a UAS geozone	
U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, and shall include its time of update together with a version number or a valid time, or both.	partial	ED-269	The standard can describe a version for a UAS zone and assign a time period to it.	
U-space service providers shall: (a) exchange any information that is relevant for the safe provision of U-space services amongst themselves; (b) adhere to an appropriate open	partial	ISO 23629-7	Generic data model to exchange all types of data in UTM. Scope covering all exchanges relevant in the U-space, but not sufficiently detailed.	It is complementary to more detailed ED-269

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
communication protocol …				

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AW DRONES

5 Flight authorisation service ③

5.1 *Description*

The Flight Authorisation(or Clearance) Service (FCS) is very extensive comprising a lot underlying services and is described as follows in the U-space draft regulation:

1. The U-space service providers shall provide UAS operators with the UAS flight authorisation for each individual flight, setting the terms and conditions of that flight, through a UAS flight authorisation service, which is more or less equivalent to the acceptance of the Flight Plan in traditional manned aviation.
2. Where U-space service providers receive from the UAS operator an UAS flight authorisation request (similar to application for a Flight Plan but in a different format), they shall:
   (a) check if the UAS flight authorisation request is complete and correct and submitted in the form set out in Annex IV;
   (b) accept the UAS flight authorisation request if the flight under the UAS flight authorisation is free of intersection in space and time with any other notified flight authorisations within the same U-space airspace in accordance with the priority rules set out in paragraph 8 (which goes beyond the traditional process for accepting a flight plan);
   (c) notify the UAS operator about acceptance or rejection of the UAS flight authorisation request (this notification is simultaneously the acceptance of the plan and the clearance to take-off);
   (d) when notifying the UAS operator about the acceptance of the UAS flight authorisation request, indicate the allowed flight authorisation deviation thresholds.
3. When issuing a flight authorisation, the U-space service providers shall use, where applicable, weather information provided by the weather information service (WIS) as referred to in Article 12.
4. Where U-space service providers are unable to grant an UAS flight authorisation in accordance with the UAS operator's request, U-space service providers may propose an alternative UAS flight authorisation to the UAS operator.
5. Upon receiving the request for an UAS flight authorisation activation referred to in Article 6(5), the U-space service providers shall confirm the activation of the UAS flight authorisation without unjustified delay.
6. U-space service providers shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different U-space services providers.

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7. U-space service providers shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.
8. When processing UAS flight authorisation requests, the U-space service providers shall apply the following priority rules in the following order:

   (a) UAS conducting special operations as referred to in Article 4 of Implementing Regulation (EU) No 923/2012 shall have priority over any other air traffic;

   (b) UAS carrying passengers shall have priority over UAS without passengers on board;

   (c) beyond visual line of sight (BVLOS) UAS operations shall have priority over visual line of sight (VLOS) UAS operations;

   (d) when two UAS flight authorisations requests have the same priority, they shall be processed on a first come first served basis.

9. U-space service providers shall continuously check existing flight authorisations against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic shared by relevant air traffic service units, in particular regarding manned aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, and update or withdraw authorisations as may be necessitated by the circumstances.
10. U-space service providers shall issue a unique authorisation number for each UAS flight authorisation. This number shall enable the identification of the authorised flight, the UAS operator and the U-space service provider issuing the UAS flight authorisation.

As currently described, the flight authorisation service encompasses a lot of underlying services and actions to be performed and as such is quite complex:

- Flight Plan/Authorisation Validation,
- Strategic deconfliction,
- Flight Plan Processing,
- Flight Plan Assistance
- and Priority Management.

Standards which have been assessed are the following:

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5.1.1 ASTM - WK63418: ASTM - New Specification for Service provided under UAS Traffic Management (UTM)

ASTM WK63418 and which has published Terms of Reference (TOR) suggesting a data exchange model between USSP's but is immature at this stage.

5.1.2 ISO - DIS 23629-7: Data model for spatial data

ISO/DIS 23629-7 has developing a very generic data model for spatial data; suggesting an attribute model to exchange data between the UAS and UTM operators.

5.1.3 ISO - CD 23629-9: Data model for spatial data

ISO TC/20 SC/16, in its WG 4 is planning as well 23629-9 on interfaces between users and several service providers, as depicted in the figure below.

However this standard is only in the planning stages and, in the absence of this or equivalent standard, it seems unlikely to safely and in a verifiable way, interface several providers of FCS in the same airspace volume.

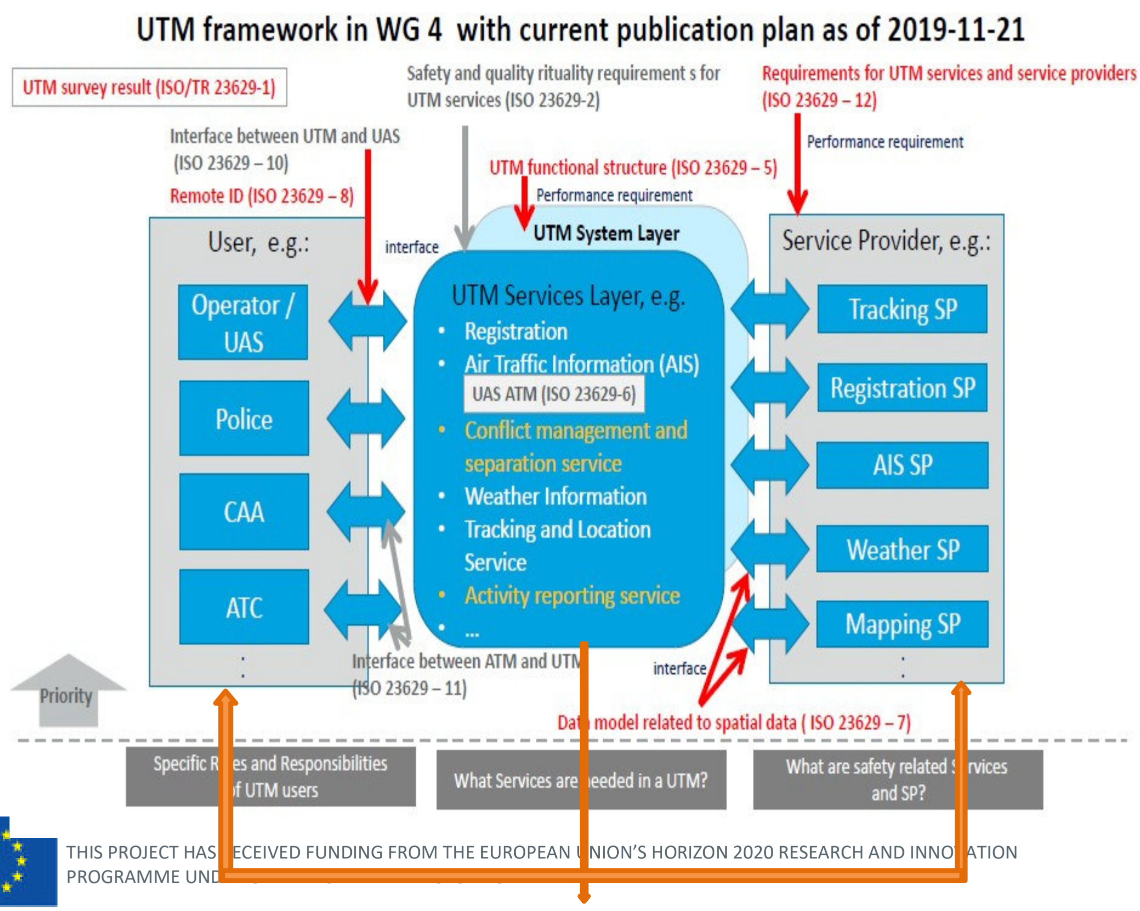

Figure 3 ISO TC/20 SC/16 WG 4 UTM model

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5.2 *Summary*

Table 10

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	WK63418	• Ongoing: planned • Version (date): February 8th 2019 • WK63418 • Exchange of all UTM data according a federated deployment model. • Compliant with draft U-space regulations: Maybe/partially (partly but currently premature)	-2
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • A very generic data model to exchange all types of data in UTM. • Compliant with draft U-space regulations: Partially; based on the deployment model this standard is not compliant with U-space, since not mentioning the possibility of several FCS providers.	7
Interface between UTM service providers and users	ISO	23629-9	• Planned: but the New Work Item Proposal (NWIP) is not even drafted. • Version date: November 2020 • Interface model to exchange all types of data among several UTM actors, including several Service Providers. • Compliant with draft U-space regulations: Yes, since covering the possibility of several FCS providers.	-2

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5.3 *Gap summary*

Table 11

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the interface among several FCS Providers	Until a standard on the interface would not be available, allowing several FCS Providers in the same DOC may not be sufficiently safe. ISO 23629-9 may fill the gap, but this standard is not even drafted.

5.4 *Conclusions & recommendations*

The Flight Authorisation Service as currently drafted in the U-space regulation encompasses a variety of individual services (e.g. strategic deconfliction, priority management, dynamic, authorisation management) and actions needed which are grouped together. This makes that in the future several standards will apply fully or partially to this services but also that currently no standard is ready to cope with the service. The standards or drafts assessed for this service were either in a premature fase (ASTM WK63418) or were applicable to this service but only covered a small, though important aspect. This is the case for standard (not yet published) ISO ISO/DIS 23629-7.

It is foreseeable that no single standard will cover the 'flight authorization service' but it will be impacted by multiple future standards.

Table 12

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. U-space SP shall provide UAS operators with flight authorisation for each individual flight, setting the terms and conditions of that flight	Covered	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	No gap
2. Upon receiving an UAS flight authorisation request USSP shall:	Partial	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	Data exchanges between UAS operator and USSP, including response from USSP to a

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
(a) check if request is complete and correct (b) accept the request if the intended flight is free of intersection in space and time with any other notified flight (c) notify UAS operator about acceptance or rejection (d) when accepting, indicate allowed flight authorisation deviation thresholds.			Related ISO 23629-12 covers safety and quality of the USSP, but it leaves details to provider's procedures or other standards not yet available.	flight authorisation request, possibly covered by ISO 23629-9, which is however only in the planning stage.
3. When issuing a flight authorisation, the USSP shall use, where applicable, weather information provided by WIS	Covered	ISO 23629-7	This standard covers the geospatial data, including "phenomena" and associated geographical position and time	No gaps
4. USSP may propose an alternative UAS flight authorisation to the UAS operator.	Covered	ISO 23629-7	This standard covers the geospatial data, including description of the intended route.	No gaps
5. Upon receiving the request, the USSP shall confirm the activation of the UAS flight authorisation without unjustified delay	Not covered	None	Maximum permissible times related to transaction, might be included in ISO 23629-9	Maximum permissible times for data exchanges between UAS operator and USSP, including response from USSP to a flight authorisation

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
				request, possibly covered by ISO 23629-9, which is however only in the planning stage.
6. USSPs shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different USSPs.	Not covered	ASTM - WK63418 Or ISO 23629-9	Both standards are in the planning stage.	Not even a preliminary draft of either candidate standard is available.
7. USSP shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.	Covered	ISO 23629-7	This standard covers the geospatial data, including attributes of the geo-limitations.	No gaps.
8. When processing UAS flight authorisation requests, the U-space service providers shall apply the following priority rules in the following order: …	Covered	ISO 23629-12	This requirement is of regulatory nature and does not require detailed technical standards. ISO 23629-12 covers safety and quality of all USSPs, including a monitoring functions to verify compliance of procedures with applicable regulations.	No gaps
9. USSP shall continuously check existing flight authorisations against new dynamic airspace restrictions and	Partial	ISO 23629-7	ISO 23629-7 contains a "dynamic data package", but however limited to	The "dynamic data package" in ISO 23629-7 should be amended, to include also dynamic airspace

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
limitations, and information about manned aircraft traffic shared by relevant ATS units, and update or withdraw authorisations as may be necessitated by the circumstances.			aircraft and whether phenomena	restrictions and limitations.
10. USSP shall issue a unique authorisation number for each UAS flight authorisation.	Partial	ISO 23629-7	ISO 23629-7 contains a UAS "Object", including the flight identifier. However, how to encode this identifier is not specified therein.	The "UAS object" in ISO 23629-7 should be amended, to include standards to encode the flight identifier. Alternatively this should be covered by ISO 23629-9

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6 Traffic information service ④

6.1 *Description*

No standards for TIS tailored to the needs of UAS are currently identified, although for manned aviation TIS is covered by EUROCAE ED-102B, while service e provisions is covered by ISO 23629-12. Further investigation by SDO's of Asterix and AWCIES is advised as source or base to develop (similar) standards.

Standards can be identified as an AMC for a Traffic information service when covering following service requirements:

1. A traffic information service provided to the UAS operator shall contain information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.

2. The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.

3. The traffic information service shall provide information about the position of other known air traffic and shall:
    a. include latitude and longitude, altitude, time of report as well as speed, heading or direction and emergency status of aircraft, when known;
    b. be updated at a frequency that the competent authority has determined in accordance with Annex I.

4. Upon receiving the traffic information services from the U-space service provider, UAS operators shall take the relevant action to avoid any collision hazard.

6.1.1 EUROCAE - ED-102B: MOPS for ADS-B and TIS on 1090 MHz

This document contains Minimum Operations Performance Standards (MOPS) for airborne equipment for Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B).

6.1.2 ISO - DIS 23629-7: Data model for spatial data

Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope.

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6.1.3 ISO - 23629-9: Interface between UTM service providers and users

This document describes an interface model to exchange all types of data among several UTM actors, including flight objects (manned or unmanned).

6.1.4 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

Includes the requirements for Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users, and covers minimum safety, quality, security and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

In addition, it specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

6.2 *Summary*

Table 13

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for ADS-B and TIS on 1090 MHz	EUROCAE	ED-102B	• Published • Version date: December 2020 • Specification of avionics for ADS-B at 1090 MHz and receiving TIS-B at 1030 MHz, applicable to manned aviation • Compliant with draft U-space regulations: No, since covering the needs and frequencies related to manned aviation.	0

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • Contains data models for flight object, either if the aircraft is manned or unmanned. • Compliant with draft U-space regulations: Partially, since not containing sufficient technical details for implementation.	7
Interface between UTM service providers and users	ISO	23629-9	• Planned: but the New Work Item Proposal (NWIP) is not even drafted. • Version date: November 2020 • Interface model to exchange all types of data among several UTM actors, including flight objects (manned or unmanned). • Compliant with draft U-space regulations: Yes, since covering the possibility of several FCS providers.	-2
UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	• External consultation (CD stage) • Version: Stage 30.20 • It contains requirements for the safety and quality of the TIS SP • Compliant with draft U-space regulations: Partially, since technical details for TIS are not covered	3

6.3 *Gap summary*

Table 14

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the technical details for transmission of TIS information on a frequency different from 1030/1090 MHz or for exchange if data between USSP and UAS Command Unit (CU).:	Flight objects, necessary to exchange TIS information, are covered by ISO 23629-7. However, lack of a standardisation of communication means might compromise uniform safety. Standardisation would be

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Gap #	Gap Description	Conclusion Recommendation
	information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	beneficial for uniform safety and EU industry perspectives.
2	Information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	The lack of a standardisation of communication and to exchange information on TIS across several providers might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
3	Information about the position of other known air traffic	Content of the traffic information has been defined, standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspectives. The case that the TIS information is provided to the CU and not directly to the unmanned aircraft should be considered.

6.4 *Conclusions & recommendations*

The standards used for General Aviation must be further investigated. A potential problem is that USSP's will use different device requirements.

Table 15

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	Partial	ISO 23629-7 and ISO 23629-12	These standards cover the definition of the "flight object" (whether manned or unmanned), and the safety and quality of the TIS provider. However, they do not cover the communication means to exchange the TIS	Interface requirements are planned to be covered through ISO 23629-9

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
			information between the USSP and the UAS operator	
Include information about manned aircraft and UAS traffic shared by other USSPs and relevant ATS units.	/	/	No standards are currently identified	No requirements are currently covered by a potential AMC
Information about the position of other known air traffic	Covered	ISO DIS 23629-7	This standard contains definition of flight "objects", whether the aircraft is manned or not.	No gaps

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7 Weather information service ⑤

7.1 *Description*

ASTM has published a Terms of Reference (ToR) for the safety and quality of the WIS Provider. On the same matter, ISO 23629-12 is already in the external consultation phase (CD). Furthermore, ISO 23629-7 defines information on “phenomena”. Based in this ToR a preliminary assessment has been conducted.

Standards can be identified as an AMC for a Weather information service when covering following service requirements:

1. When providing a weather information service, U-space service providers shall:
   a. collect weather data, provided by trusted sources, to maintain safety, supporting operational decisions of other U-space services;
   b. provide the UAS operator with weather forecasts and actual weather information either before or during the flight.

2. The weather information service shall include, as a minimum:
   a. wind direction measured clockwise through the true north and speed in metres per second, including gusts;
   b. the height of the lowest broken or overcast layer in hundreds of feet above ground level;
   c. visibility in metres and kilometres;
   d. temperature and dew point;
   e. indicators of convective activity and precipitation;
   f. QNH
   g. the location and time of the observation, or the valid times and locations of the forecast.

3. U-space service providers shall provide weather information that is up-to-date and reliable to support UAS operation.

7.1.1 ASTM - WK73142: New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.

Potentially suitable as all requirements are being referred to are being addressed. Only TOR available.

7.1.2 ISO - DIS 23629-7: Data model for spatial data

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Specifies the data model that is related to various spatial information for common use between the UAS service provider and the system for operation control, e.g. UTM. The data model is included in the scope in the way that it specifies the names of the items for the model, while the communication architecture is not included in the scope.

7.1.3 ISO - 23629-12: UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers

This standard includes the requirements for Services and Service Providers in the context of UAS Traffic Management (alias U-Space) for Unmanned Aircraft Systems (UAS) and other equipped airspace users.

This document covers minimum safety, quality, security and privacy requirements for safety critical and safety related UTM services and related SPs and for operation support services.

This document, in addition, specifies technical requirements enabling the Service Provider of Aeronautical Information Management for UAS (AIMU), UTM users and other service providers (SPs) to exchange digital data and information.

7.2 *Summary*

Table 16

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
New Specification for Weather Supplemental Data Service Provider (SDSP) Performance.	ASTM	(WK73142)	• Planning phase • Version (date): April 2020 • Only ToR available • A lack of meteorological information might hinder UAS operations and compromise safety • Good basis to full requirements as the requirements are being addressed in the ToR • Conclusion: ToR indicate a full coverage	-4

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Data model for spatial data	ISO	DIS 23629-7	• Ongoing: External Consultation (comments on DIS until 16 Feb 2021) • Version date: November 2020 • Contains data models for meteorological phenomena. • Compliant with draft U-space regulations: Partially, because only defining which information should be exchanged	7
UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	ISO	ISO 23629-12	• External consultation (CD stage) • Version: Stage 30.20 • It contains requirements for the safety and quality of the WIS SP • Compliant with draft U-space regulations: Partially, but required WIS information is specified in ISO 23629-7	3

7.3 *Gap summary*

Table 17

Gap #	Gap Description	Conclusion Recommendation
1	Provision of weather data before and during the flight	A lack of meteorological information might hinder UAS operations and compromise safety. Further standards on interfaces between USSPs and UAS Operators should be developed. One possibility is ISO 23629-9, being planned by WG4 of ISO TC/20 SC/16
2	Content and format of weather data messages	No gaps identified
3	Safety and quality of weather information	No gaps identified at the level of consensus based standards, since ISO 23629-12 covers this topic.

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Gap #	Gap Description	Conclusion Recommendation
		However, a general AMC published by EASA and specifying under which conditions consensus-based industry standards may constitute presumption of compliance with the rules, is highly desirable. AMC to AIR-OPS already contain a similar AMC, which, for ease of reference is reproduced in Annex IV.

7.4 *Conclusions & recommendations*

More research on how to present the weather information to the operators must be done.

QNH will be added to the requirements list

Table 18

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
Provision of weather data before and during the flight	Partial	ISO CD 23629-7	• Contains data models for meteorological phenomena. • Partially compliant with draft U-space regulations, because only defining which information should be exchanged, but not interfaces	236297 should be complemented by 235629-9 specifying the interfaces to exchange the information
Content and format of weather data messages	Covered	ISO CD 23629-7	• Contains data models for meteorological phenomena. •	No gaps identified
Safety and quality of weather information	Covered	ISO CD 23629-12	• Contains safety and quality requirements for all USSPs, including WIS	No gaps identified

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8 Conformance monitoring service ⑥

8.1 Description

Standards can be identified as an AMC for a Conformance monitoring service when covering following service requirements[4]:

1. A conformance monitoring service shall enable the UAS operators to verify whether they comply with the requirements set out in Article 6.1**(1)** and the terms of the flight authorisation. To this end, that service shall alert the UAS operator when the flight authorisation deviation thresholds are violated and when the requirements in Article 6.1**(1)** are not complied with.

2. Where the conformance monitoring service detects a deviation from the flight authorisation, the U-space service provider shall alert the other UAS operators operating in the vicinity of the UAS operators, other U-space service providers offering services in the same airspace, relevant air traffic services units and relevant authorities.

(1): 1. When operating in the U-space airspace, UAS operators shall:

*a. ensure that the UAS to be operated in the U-space airspace have the capabilities and performance requirements determined in accordance with Article 3.4.a**(2)***

*b. ensure that during their operations, the necessary U-space services referred to in Article 3.2 and 3.3**(3)** are used, and their requirements complied with;*

*c. comply with the applicable operational conditions and airspace constraints referred to in Article 3.4.c**(4)***

(2): 4. For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I [4], Member States shall determine:

a. the UAS capabilities and performance requirements;

(3): 3.2 All UAS operations in the U-space airspace shall be subject to at least the following mandatory U-space services:

a. the network identification service referred to in Article 8;
b. the geo-awareness service referred to in Article 9;
c. the UAS flight authorisation service referred to in Article 10;
d. the traffic information service referred to in Article 11.

3.3 For each U-space airspace, based on the airspace risk assessment MS may require additional U-space services selected from the services referred to in Articles 12 and 13.

(4): 3.4 For each U-space airspace, based on the airspace risk assessment and using the criteria set out in Annex I, Member States shall determine:

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c. *the applicable operational conditions and airspace constraints.*

This service aims to the conformance to the flight authorisation considering weather, height, waypoints, etc., so not relating directly to geocaging (no aerospace restrictions, but conformance to the flight authorisation).

Two standards have been identified:

8.1.1 EUROCAE - ED-270: MOPS for Geocaging

The standard is a Minimum Operational Performance Standard and this specifies the minimum performance expected for geocaging but does not prescribe design or implementation.

8.1.2 ASTM - F3442 / F3442M - 20: Standard Specification for Detect and Avoid System Performance Requirements

This standard describes detect and avoid (DAA), i.e. a subsystem within the UAS providing the situational awareness, alerting, and avoidance necessary to maintain safe BVLOS operation of the unmanned aircraft in the presence of other manned aircraft. It is not applicable to the avoidance of unmanned aircraft to manned aircraft.

This standard does not address conformance monitoring directly.

ASTM is working on conformance monitoring through WK63418 Standard Specification for UAS Service Supplier (USS) Interoperability.

8.2 *Summary*

Table 19

Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
MOPS for Geocaging	EUROCAE	ED-270	• Published • Version (date): June 2020 • MOPS for geocaging • Possible AMC, but lacks design or implementation details	4

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Standard title	SDO	Doc. Ref.	Status, scope & compatibility	Global score
Standard Specification for Detect and Avoid System Performance Requirements	ASTM	F3442 / F3442M - 20	• Published • Version (date): November 2nd 2020 • Focus on DDA systems on board a UAS • Only partially compliant with U-space regulation: does not address conformance monitoring directly	2

8.3 *Gap summary*

Table 20

Gap #	Gap Description	Conclusion Recommendation
1	Identified standards lack full coverage and design and implementation details.	The EUROCAE ED-270 is focused on geo-caging and thus covers the requirements on a high level only, so it is recommended to detail the design and implementation. The lack of the latter might affect the efficiency of UAS operations and compromise safety.

8.4 *Conclusions & recommendations*

There is still a need for security standards for connections between CISP and USSP with reference to CMS (and other services).

Table 21

Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
1. alert the UAS operator when the flight authorisation deviation	Partial	EUROCAE ED-270	• Only a Minimum Operational Performance Standard is available that remains to high level and only	Does not provide details on design or implementation.

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Requirement	Coverage	Recommended standard	Limitations/notes	Gaps
thresholds are violated			focuses on geocaging.	
2. alert the other UAS operators operating in the vicinity of the UAS operators violating the deviation thresholds	Partial	EUROCAE ED-270	• Only a Minimum Operational Performance Standard is available that remains to high level and only focuses on geocaging.	Does not provide details on design or implementation.

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9 Annex I: Standards identified

9.1 *Standards per USS/Category*

Table 22 Standards per USS/Category

USS/Category	Standard title	SDO	Doc./WG Ref.
network identification service	UAS Remote ID and Tracking	ASTM	F3411-19
	MOPS for UAS E-Identification	EUROCAE	• ED-282 • Prepared by WG 105 (UAS) SG 32 (e-identifcation)
	UAS Traffic Management (UTM) — Part 8: Remote identification	ISO	PWI 23629-8
geo-awareness service	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	EUROCAE	ED-269
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	ISO	ISD 23629-7
	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	(WK6341)
UAS flight authorisation service	New Specification for Service provided under UAS Traffic Management (UTM)	ASTM	(WK63418)
	UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model	ISO	ISO/DIS 23629-7

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USS/Category	Standard title	SDO	Doc./WG Ref.
	related to spatial data for UAS and UTM		
traffic information service	/		
weather Service	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	ASTM	(WK73142)
conformance monitoring sercvice	MOPS for Geocaging	EUROCAE	ED-270
	Standard Specification for Detect and Avoid System Performance Requirements	ASTM	F3442-20

9.2 *Standards per SDO*

Table 23 Standards per SDO

SDO	Standard title	Doc. Ref.	Comments
ASTM	UAS Remote ID and Tracking	F3411-19	Linked to: • Network Identification Serice
	New Specification for Service provided under UAS Traffic Management (UTM)	(WK6341)	Linked to: • Geo-awereness service
	New Specification for Service provided under UAS Traffic Management (UTM)	(WK63418)	Linked to: • Flight authorisation service • Communication service
	New Specification for Weather Supplemental Data Service Provider (SDSP) Performance	(WK73142)	Linked to: • Weather information service
	Standard Specification for Detect and Avoid System Performance Requirements	F3442-20	Linked to: • Conformance monitoring service

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SDO	Standard title	Doc. Ref.	Comments
EUROCAE	MOPS for UAS E-Identification	ED-282	Linked to: • Network Identification Serice
	UTM Geo-Fencing - Minimum Operational Performance Standard for UAS Geo-Fencing	ED-269	Linked to: • Geo-awareness service
	MOPS for Geocaging	ED-270	Linked to: • Conformance monitoring service
ISO	UAS traffic management (UTM) — Part 5: UTM functional structure	CD 23629-5	Linked to: • All services considered in this document
	UAS traffic management (UTM) — Part 7: Data model for spatial data	DIS 23629-7	Linked to: • All services considered in this document
	UAS Traffic Management (UTM) — Part 8: Remote identification	ISO 23629-8	Linked to: • Network Identification Service
	UAS traffic management (UTM) — Part 9: Requirements for interfaces between UAS operators and UTM SPs	ISO 23629-9	Linked to: • All services considered in this document
	UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	CD 23629-12	Linked to: • All services considered in this document
ASD-STAN	Aerospace series - Unmanned Aircraft Systems - Part 002: Direct Remote identification	prEN 4709-002	• Not applicable for U-space requirements: only DRI • specifies the messages listed, EXCEPT for the emergency status if the unmanned aircraft, this does

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SDO	Standard title	Doc. Ref.	Comments
			NOT apply for add-on devices

9.3 *Other standards and materials to be screened*

Table 24 Standards to be screened

SDO	Standard
ASTM	WK69690, Specification for Surveillance UTM Supplemental Data Service Provider Performance
IEEE	IEEE P1939.1, Standard for a Framework for Structuring Low Altitude Airspace for Unmanned Aerial Vehicle (UAV) Operations
IETF	Secure UAS Network RID and C2 Transport
JARUS	JARUS WG-6 UTM Subgroup (Annex H) is developing recommendations on roles and responsibilities of USP in the context of Safety Assessments of UAS Operations

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10 Annex II: Sources

[1]	EASA (2019, AMC & GM to Commission Implementing Regulation (EU) 2019-947 - Issue 1
[2]	AW-Drones (2020) D2.3: Methodology for the assessment of drone standards
[3]	Opinion No 01-2020 high level framework for the U-space
[4]	Draft Commission Implementing Regulation on a regulatory framework for the U-space
[5]	ISO Committee Draft (CD) 23629-12 UAS Traffic Management (UTM) — Part 12: Requirements for UTM Services and Service Providers
[6]	ISO CD 23629-5, UAS traffic management (UTM) — Part 5: UTM functional structure
[7]	Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
[8]	European Union (2019), Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, as lastly amended by Commission Regulation 2020/746.
[9]	Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91
Web site	Eurocae (https://www.eurocae.net/)
Web site	ASTM (https://www.astm.org/COMMITTEE/F38.htm)
Web site	ISO https://www.iso.org/committee/5336224.html
Web site	FAA (https://www.faa.gov/uas/research_development/remote_id/industry/)

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Web site	Using Mobile Networks to Coordinate – Unmanned Aircraft Traffic – GSMA white paper (https://www.gsma.com/iot/wp-content/uploads/2018/11/Mobile-Networks-enabling-UTM-v5NG.pdf)

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11 Annex III: Maturity Correlation Table

Different SDOs use different terminology for the phases of respective development projects. A correlation table for their respective semantics is provided:

Table 25 Maturity correlation of standards

AW-Drones maturity	ORGANISATION					
	JARUS	ISO	CEN CENELEC	EUROCAE	ASTM	RTCA
Planning	Terms of Reference (ToR)	Stage 10 (New Work Item)	New Work Item	ToR	ToR	ToR
Drafting	Drafting	Stage 20 (Preparatory – WD)	Drafting (including through ASD-STAN)	Drafting (DP)	Drafting	Drafting
Internal consultation	Internal consultation	Stage 30 (Committee State – CD)	ASD-STAN consultation (prEN)	Peer review (ED)	Sub-Committee ballot	N.A.
External consultation	External consultation	Stage 40 & 50 (Enquiry & Approval stages – DIS & FDIS)	Enquiry (FprEN)	Open Consultation (ED)	Committee ballot	Final Review and Comment (FRAC)
Published	Published	Stage 60 (publication)	Published (EN)	Published (ED)	Publication	Publication (DO)
Recognised	**NA: JARUS deliverables are recommendations for regulation, not consensus-based industry standards to be recognised by EASA**	**Mentioned in at least one AMC or GM published by EASA (or proposed in an NPA)**				

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12 Annex IV: Generic EASA AMC to link rules to industry standards

The model could be the existing AMC to Part-ARO, related to EU Regulation 965/2012 (AIR-OPS)

AMC1 ARO.GEN.305(b);(c);(d);(d1) Oversight programme

INDUSTRY STANDARDS

(a) For organisations having demonstrated compliance with industry standards, the competent authority may adapt its oversight programme, in order to avoid duplication of specific audit items.
(b) Demonstrated compliance with industry standards should not be considered in isolation from the other elements to be considered for the competent authority's risk-based oversight.
(c) **In order to be able to credit any audits performed as part of certification in accordance with industry standards, the following should be considered**:

(1) the demonstration of compliance is based on certification auditing schemes providing for **independent and systematic verification**;
(2) the existence of an **accreditation scheme** and accreditation body for certification in accordance with the industry standards has been verified;
(3) certification audits are **relevant** to the requirements defined in Annex III (Part-ORO) and other Annexes to this Regulation as applicable;
(4) the scope of such certification audits can **easily be mapped** against the scope of oversight in accordance with Annex III (Part-ORO);
(5) **audit results are accessible to the competent authority** and open to exchange of information in accordance with Article 15(1) of Regulation (EC) No 216/2008; and
(6) the audit **planning intervals** of certification audits i.a.w. industry standards are compatible with the oversight planning cycle.

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13 Annex V: Standards' Assessment

1. U-space Standards' Assessment: https://seafile.dblue.it/f/06f462cc8640401d8e59/

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