AW-Drones proposed standards – 3rd iteration (SORA)

D4.3

AW-Drones

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AW-Drones

Abstract

The AW-Drones project aims at harmonising 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 third and final 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. Additionally, this deliverable includes the second iteration of the AW-Drones assessment of standards for the U-space, and the first iteration of the AW-Drones assessment of standards for the SC Light-UAS, which are included as a separate document. For each requirement, 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 to fully meet the criterion.

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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.
Deliverable D4.3 is divided in three sections, covering existing standards applicable to SORA criteria (Part I), U-space services (Part II), and SC Light-UAS requirements (Part III).
This document presents the results of the third and final 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 (in Part I), U-Space service (in Part II), and SC Light-UAS requirement (Part III) this deliverable 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.
- 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;

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  - Standards have a limited scope (e.g. Maximum Take-off Mass (MTOM) less than 25kg, only rotorcraft, etc.);
  - 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 third 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 EASA 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 focused on integrating the second iteration's work on standards applicable to the SORA methodology, while including an assessment of standards deemed applicable to the identified U-space services, as listed in in Commission Implementing Regulation 2021/664 [2]. The third and final iteration, provided in this document, alongside updating the previous iterations' results, integrates them by identifying the standards which are deemed applicable to the requirements set in the Special Condition Light-UAS [3].
This document provides the results of the aforementioned assessment. In line with the iterative approach of the AW-Drones project, this deliverable provides the third 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).
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

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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

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 [4], 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 Operational Safety Objective and mitigation (in Part I), U-Space service (in Part II), and SC Light-UAS requirement (in Part III), 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 [4].
- 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 [4].
- Recommendations about the preferred standards and suggested strategies to fill the identified gaps based on their score.

The assessment in this deliverable (Part I, SORA) 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, and never recommended.
- The maturity of the standards is updated to the last assessment conducted.
- 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 to which the consortium had access. For the others, a preliminary assessment based on the publicly available information was provided.

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.

The present document provides the results of the **third and final iteration** of the standards deemed applicable to the criteria within the SORA methodology. The approach employed in this methodology holds some **differences with respect to the previous iteration**, namely:

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- The "Effectiveness to fulfil the SORA requirement" criterion was **removed from the multi-criteria analysis** to assess standards, and it is therefore not kept in consideration when evaluating a standard's score. As such, scores for recommended standards in this iteration are lower: a standard scoring +5 now holds the same value as one scoring +10 in the previous iteration. This was done to avoid standards with full coverage but limited scope to be penalised, such as, for example, standards fully covering a requirement, but for a limited configuration (e.g., only multicopters).
- Since this iteration also features a section on standards applicable to the requirements set in the SC Light-UAS (Part III of D4.3), OSOs and Mitigations (or individual criteria), as well as gaps describing the **technical design** of a system, have not been assessed in Part I of the deliverable (SORA), but rather assessed in Part III, due to their relevance with the Special Condition.

1.3 Structure of the document

This document, Part I of D4.3, is focused on the assessment of standards applicable to the SORA methodology. It 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 cover the 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:
    - A description of the criterion as published in the AMC & GM to Commission Implementing Regulation (EU) 2019/947 [1];
    - The list of standards that was considered in the assessment and could be used to fulfil the criterion, taking into account the maturity, type of standard, cost of compliance, environmental impact and impact on EU industry competitiveness. For details regarding the assessment methodology, the reader should refer to the 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 assessed over 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 complete assessments with the rationales behind the global scores assigned to each standard.

1.4 How to Read This Document

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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 according to the SORA methodology;
- Grey shading indicates that a standard is not required according to the SORA methodology.

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.

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:

Criteria

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 according to the SORA methodology are highlighted in grey, while those for which a standard is needed are white.

Description

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

1.4.2 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 effectiveness to fulfil the criterion. The columns are divided as follows:

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 to their availability; standards that needed 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.

1.4.3 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. Limitations 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).

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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

1.4.4 Gap summary

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, as they keep in consideration the combination of available standards.

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.

Conclusions and Recommendations

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

1.4.5 Gap details

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A Gap Details table evaluates each gap on the basis of the criteria defined in [4] 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

Low to high impact of the gap to fill the criterion (see [4] 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

1.4.6 Conclusions and Recommendations

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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 [4]; for details on how the global score has been computed for each standard refer to Annex 1.

1.5 List of Acronyms

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 System
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

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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
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.

Therefore, 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 highlights 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, 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 => 5).
- Yellow shading indicates the proposed standard is potentially suitable to be recommended but there exist constraints (e.g. high cost for implementation) that does not allow to recommend them immediately (i.e. 0 < score < 5).
- Grey shading indicates that a standard is not required.
- Red shading indicates that the criterion is currently not covered by any standard.

In this iteration, OSOs and Mitigations (or individual criteria) describing the technical design of a system have not been assessed in this document, but rather assessed in Part III (SC Light-UAS), due to their relevance with the Special Condition.

Table 1

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score

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M1 - Integrity	*Non-tethered operation* - Criterion #1 (Definition of Ground Risk Buffer)	Low Medium	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
			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
		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
			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	6
		Low	N.A.	NO STANDARD REQUIRED	

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	Non-tethered operation - Criterion #2 (Evaluation of people at risk)	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	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.
		High			
	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	4

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	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.
		High			

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	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	4
				EASA AMC2 UAS.SPEC.030(3)(e) - Application for an operational authorisation	8

Table 3

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M2 - Integrity	Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED	
		Medium	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.
		High			
	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

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M2 - Assurance	Criterion #1 (Technical Design)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.
		High			
	Criterion #2 (Procedures, if applicable)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Full	EASA AMC2 UAS.SPEC.030(3)(e) - Application for an operational authorisation	8
		High			
	Criterion #3 (Training, if applicable)	Low	N.A.	NO STANDARD REQUIRED	
		Medium High	N/A	NO STANDARD AVAILABLE	N.A.

Table 5

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M3 - Integrity	Integrity Criterion	Low	N/A	NO STANDARD REQUIRED	
		Medium	Full	AMC3 UAS.SPEC.030(3)(e): EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	10
		High	Full		12

Table 6

Mitigation	Criterion	Robustness	Coverage	Recommended standard	Score
M3 - Assurance	Assurance Criterion #1 (Procedures)	Low	N/A	NO STANDARD REQUIRED	
		Medium	Full	AMC3 UAS.SPEC.030(3)(e): EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	10
		High	Full		12
	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

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			Full	AMC3 UAS.SPEC.030(3)(e): EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	10
		High	Partial	ISO 23665 Unmanned aircraft systems -Training for personnel involved in UAS operations	2
			Full	AMC3 UAS.SPEC.030(3)(e): EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	12

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

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

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		Arc-c	Partial	F3442 - Detect and Avoid performance Requirements	6
		Arc-d	Partial	DO-365: MOPS for Detect and Avoid (DAA) Systems-Phase 1	2
				DO-366 Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance	3
				ED-265 Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)	4
				RTCA DO-386: Minimum Operational Performance Standards for Airborne Collision Avoidance System Xu (ACAS Xu)	3

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	Partial	ISO 21384-3: Operational Procedures	4

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		High	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 High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 12

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 03 - Integrity	Criterion 1	Low	Full	NO STANDARD REQUIRED	
		Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	5
			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	4
			Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	3
			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	7
				JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	5

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				MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	3

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	5
			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	4
			Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	3
			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	7
				JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes	5
				MSG-3 - Operator/Manufacturer Scheduled Maintenance Development	3
	Criterion 2 (Training)	Low	N/A	NO STANDARD REQUIRED	
		Medium	N/A	NO STANDARD REQUIRED – ISO 23665 may be used as guidance	4

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		High	Full	NCATT – Unmanned Aircraft System (UAS) Maintenance Standard	6

Table 14

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 04 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 15

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 05 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 16

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 06 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 17

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 07 - Integrity	Criterion #1	Low	Full	ISO 21384-3: Operational Procedures	6
		Medium	Full	ISO 21384-3: Operational Procedures	6
		High	Full	ISO 21384-3: Operational Procedures	6

Table 18

Objective	Criterion	Robustness	Coverage	Recommended standard	Score

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OSO 07 - Assurance	Criterion #1	Low	Full	ASTM F2909 – 19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	8
		Medium	Full		8
		High	Partial		8
	Criterion #2	Low	Full	ISO 23665 – Training for personnel involved in UAS operations	6
		Medium	Full		6
		High	Partial		6

Table 19

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	4
			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	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 High	Partial	ISO 21384-3: Operational Procedures	2

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			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8

Table 20

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 08, 11, 14, 21 - Assurance	Criterion	Low	N/A	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3: Operational Procedures	2
			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
		High	Partial	ISO 21384-3: Operational Procedures	2
			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8

Table 21

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	8

Table 22

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	8

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				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	8
				ASTM F3330-18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	6

Table 23

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 10/12 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 24

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
				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

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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.	8
				Guidelines for the use of multi-GNSS solutions for UAS	3
				ISO 23629-12 - Requirements for UTM services and service providers	4

Table 25

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	4

Table 26

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 16 – Integrity/Assurance	Criterion #1 Procedures	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8

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		High	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
	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 27

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 28

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 18 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 29

Objective	Criterion	Robustness	Coverage	Recommended standard	Score

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OSO 19	Criterion #1 (Procedures and checklists)	Low	N.A.	NO STANDARD REQUIRED	
		Medium	Partial	ISO 21384-3 UAS – Part 3: Operational Procedures	2
			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
		High	Partial	ISO 21384-3 UAS – Part 3: Operational Procedures	4
			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
	Criterion #2 (Training)	Low (integrity only)	Partial	JARUS Recommendations for RPC	7
				ASTM F3266-18: Standard Guide For Training For Remote Pilot In Command Of Unmanned Aircraft Systems (UAS) Endorsement	4
				ASTM F3379-20: Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	4
				ASTM F3330 – 18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	2
				ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	2
		Medium		JARUS Recommendations for RPC	7

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		(Integrity and Assurance)		ASTM F3266-18: Standard Guide For Training For Remote Pilot In Command Of Unmanned Aircraft Systems (UAS) Endorsement	6
				ASTM F3379-20: Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	4
				ASTM F3330 – 18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	4
				ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	4
				ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	4
		High (Integrity and Assurance)		JARUS Recommendations for RPC	7
				ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	6
				ASTM 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	6

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	Criterion #3 (UAS design)	N.A.	Low Medium High	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 30

Objective	Criterion	Robustness	Coverage	Recommended standard		Score
OSO 19 - Assurance	Criterion #2 (Training)	Low	Covered above, together with Integrity.			
		Medium				
		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.	6

Table 31

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: LIGHT UNMANNED AIRCRAFT SYSTEMS AIRWORTHINESS REQURIEMENTS	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

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			Partial	STANAG 4703: LIGHT UNMANNED AIRCRAFT SYSTEMS AIRWORTHINESS REQURIEMENTS	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: LIGHT UNMANNED AIRCRAFT SYSTEMS AIRWORTHINESS REQURIEMENTS	5

Table 32

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 33

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

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			Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
		High	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	8
	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)	7
			Partial	DOC - 1009 - Manual on Remotely Piloted Aircraft Systems (PSURs)	7
				ARP 5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	4
				ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	3
				F3330 – 18: Standard Specification for Training and the Development of Training Manuals for the UAS Operator	2

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		High	Partial	ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	4
				ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	4

Table 34

Objective	Criterion	Robustness	Coverage	Recommended standard	Score
OSO 24 – Integrity/Assurance	Criterion #1	Low Medium High	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	N.A.

Table 35

Objective	Criterion	Requirement	Coverage	Recommended standard	Score
Adjacent Area/Airspace Considerations	Criteria #1/#2	All	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)	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 two categories, to better highlight their nature:

- Procedures: Gaps that refer to specific instructions and protocols associated with UAS operations.
- Training: Gaps that refer to guidelines on how to conduct training and structure training material for personnel involved in UAS operations.

Gaps related to the SORA criteria describing the technical design of the UAS, any of its components and/or external services are addressed in the SC Light-UAS section (Part III).

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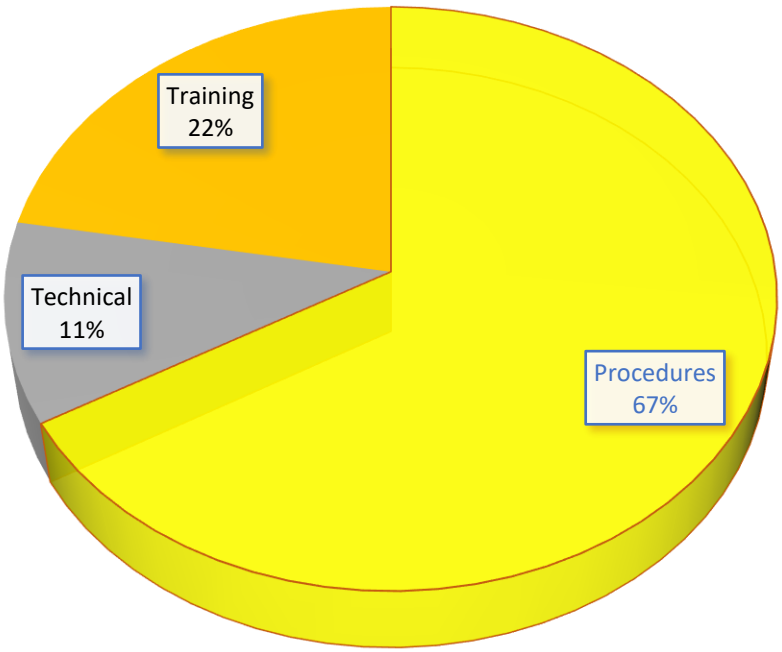

Figure 6 Overview of gaps identified

Table 36 Strategic Mitigations for Ground Risk: Gap Overview

Mitigation	Gap	Classification	Score

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M1	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
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	N/A		

Table 37 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

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	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 38 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	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 03	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 04	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 05	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 06	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
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 gaps identified.		
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

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	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
	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	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 19	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
OSO 20	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		
OSO 23	There are no standards/guidelines to define how to determine adequate environmental/ meteorological conditions for safe operations.	Procedures	-5
	No current standard completely covers third-party competence for checking environmental/meteorological conditions for both syllabus and skills.	Procedures	+2
OSO 24	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		

Table 39 Adjacent Area/Airspace Considerations: Gap Overview

Mitigation	Gap	Classification	Score

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Adjacent Area/Airspace Considerations	**Gaps related to technical design criteria are assessed in Part III of D4.3 (SC Light-UAS).**		

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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 40 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 41 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 42 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 43 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 44 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									
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3											F	F
AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.	P	P	P		P							

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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
Unmanned Aircraft Systems — Part 006: Means to Terminate Flight, requirements, and verification	ASD-STAN	prEN 4709-006	F	F	F									
Assurance														
AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	DGAC	N.A.					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	
AMC2 UAS.SPEC.030(3)(e) - Application for an operational authorisation	EASA	NPA of 09/2021											F	F

3.1.4 Integrity Coverage Detail

Table 45

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 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	
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 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	

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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 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	
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

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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	
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

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 006: Means to Terminate Flight, requirements, and verification	ASD-STAN	prEN 4709-006	F	F	F										Still in draft phase.

3.1.1 Assurance Coverage Detail

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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	
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 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	

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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 52

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

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	
AMC2 UAS.SPEC.030(3)(e)	EASA	NPA of 09/2021											F	F	
This AMC was developed specifically to show compliance to requirements regarding operational procedures.															

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3.1.2 Gaps

3.1.2.1 Summary

Table 53 Gap Summary – M1

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	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.

3.1.2.2 Details

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Table 54

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	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**

3.1.3 Conclusions and Recommendations

Criterion #1 of Mitigation M1 (tethered case) addresses the technical design of the tether, and is addressed in Part III of D4.3 (SC Light-UAS).

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The M1 mitigation requirements are not adequately covered by existing standards for the non-tethered case. 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.

However, the new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for the criteria regarding operational procedures, and hence is applicable and fully covers the assurance of Criterion #2 (procedures) of the tethered case. While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.

Table 55 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Non-tethered operation - Criterion #1 (Definition of Ground Risk Buffer)	Low Medium	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	
		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	

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		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	
	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	
		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	6	
	Low	N.A.	NO STANDARD REQUIRED			

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Non-tethered operation - Criterion #2 (Evaluation of people at risk)	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	
Tethered operation - Criterion #1 technical design	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)			
	High					
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	
		Full	ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	Not specific for installation and maintenance of a tether, but addresses the procedures adequately.	4	

Table 56 Recommended Standards - Assurance

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

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Non-tethered operation - Criterion #1 (Definition of the ground risk buffer)	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	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)			
	High					
Tethered operation - Criterion #2 procedures	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	Full	EASA NPA 2021-09 - AMC2 UAS.SPEC.030(3)(e) Application for an operational authorisation	Section “3 Criteria for the level of assurance” applicable. It will be recognised by EASA once the NPA is published.	8	

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			ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures	Not specific for installation and maintenance of a tether, but addresses the procedures adequately.	4	

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

3.2.1 Requirement Description

Table 57 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Technical Design)	Low	Does not meet the "Medium" level criterion
	Medium	• 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	

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Criterion #3 (Training, if applicable)	Low Medium High	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.

Table 58 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).
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.

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	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 59 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 Aircraft Emergency Parachute Recovery Systems	ASTM	F3408-21		P	P	P	P	P			
Assurance											
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)					F	F			

3.2.3 Integrity 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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Standard Specification for Aircraft Emergency Parachute Recovery Systems	ASTM	F3408-21		P	P	P	P	P				- Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. - not UAS specific demands are given within the standard (like interconnection to UAS avionics) - automatic activation is not within the scope of this standards - A competent third party for validation efforts is not provided. The CAA will have to define competent third parties. - Requirements for Criteria #2 only high-level criteria not addressing procedures but general information, it is thus regarded as partially applicable to this criteria
Notes: F3322-18 is a specification that defines integration and test requirements for the parachute systems. It is tailored for manned aviation and pilot activation and thus does not consider UAS specific aspects. It might however be used to provide evidence on the strength of the parachute system and the structural aircraft integration. Test considerations are given to prove these aspects and high-level requirements are given for maintenance and related information. No requirements are presented related to training.												

3.2.4 Assurance Coverage Detail

Table 60

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 Specification for Aircraft Emergency Parachute Recovery Systems	ASTM	F3408-21		P	P	P	P	P				- Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. - not UAS specific demands are given within the standard (like interconnection to UAS avionics) - automatic activation is not within the scope of this standards - A competent third party for validation efforts is not provided. The CAA will have to define competent third parties. - Requirements for Criteria #2 only high-level criteria not addressing procedures but general information, it is thus regarded as partially applicable to this criteria
Notes: F3322-18 is a specification that defines integration and test requirements for the parachute systems. It is tailored for manned aviation and pilot activation and thus does not consider UAS specific aspects. It might however be used to provide evidence on the strength of the parachute system and the structural aircraft integration. Test considerations are given to prove these aspects and high-level requirements are given for maintenance and related information. No requirements are presented related to training.												

Table 61

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)					F	F				
This AMC was developed specifically to cover the criteria regarding operational procedures.												

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3.2.5 Gaps

3.2.5.1 Summary

Table 62 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.
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.

3.2.5.2 Details

Table 63

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	No standards for automated termination system activation and	Safety (3)	High	Implementation standards for automated activation of recovery systems need to be developed if this	-1	-3

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	documents that explicitly address techniques for the reduction of the effects of impact dynamics and post impact hazards as required.			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.		
		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
		Social Acceptance (1)	Neutral	No impact	0	0
Total Weighted Score						**-6**

Table 64

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

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		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 65

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
3	No standards describing the training for ground impact measures for remote crews	Safety (3)	Medium	Ground impact measures are mostly quite intuitive, usually no training is required. However, systems that require training should have a standard describing the content of this training.	0	0
		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**

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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**

3.2.6 Conclusions and Recommendations

Criterion #1 of Mitigation M2 addresses the technical design of the equipment used to reduce the effect of UA impact dynamics, and is addressed in Part III of D4.3 (SC Light-UAS).

For Criterion #3, no standard has been identified to fully cover the training requirements to reduce dynamics of 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).

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In addition, the new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for the criteria regarding operational procedures, such as the assurance of Criterion #2 (Procedures), which is therefore fully covered. While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.
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 66 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Technical Design)	Low	N.A.	NO STANDARD REQUIRED			
	Medium		For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)			
	High					
Criterion #2 (Procedures, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standard defining procedures for installation and maintenance

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Criterion #3 (Training, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standards describing the training for ground impact measures

Table 67 Recommended Standards - Assurance

Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Technical Design)	Low	N.A.	NO STANDARD REQUIRED			
	Medium		For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)			
	High					
Criterion #2 (Procedures, if applicable)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically to cover the criteria regarding operational procedures. It will be recognised by EASA once the NPA is published.	8	No gaps identified.
	High					
Criterion #3 (Training, if applicable)	Low	N/A	NO STANDARD REQUIRED			
	Medium	N/A	NO STANDARDS AVAILABLE		N/A	No standards describing the training for ground impact measures
	High					

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

3.3.1 Requirement Description

Table 68 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 69 Assurance Requirements' Description

Criterion	Robustness	Description
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.

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	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)

Table 70 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			

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Unmanned aircraft systems -Training for personnel involved in UAS operations	ISO	23665					P	P		P	P
Emergency Response Plan	IATA	N/A		P	P		P	P			
EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	EASA	AMC3 UAS.SPEC.030(3)(e)		F	F		F	F		F	F

3.3.3 Coverage Detail

Table 71

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
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.												

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Table 72

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 73

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	

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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.												

Table 74

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	
EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	EASA	AMC3 UAS.SPEC.030(3)(e)		F	F		F	F		F	F	N.A.
Notes: This AMC was specifically developed by EASA to show compliance to medium and high levels of assurance of mitigation M3, and hence will be recognised once published. While not formally recommended as a means of compliance for the training criterion, a syllabus following the content of the AMC could cover this criterion as well.												

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3.3.4 Gaps

No gaps are identified: the available standards cover the mitigation.

3.3.5 Conclusions and Recommendations

The new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for mitigation M3 - ERP. While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.
The EASA AMC exhaustively defines all the required content of an ERP, as well as the methodology for its validation and implementation. While not formally recommended as a means of compliance for the training criterion, a syllabus following the content of the AMC could cover this criterion as well.

Table 75 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Integrity Criteria	Low	N/A	NO STANDARD REQUIRED			
	Medium	Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	The AMC was developed specifically by EASA to cover the requirement. While still an NPA, the AMC will be published in Q1 of 2022.	10	No gaps identified
	High	Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021		12	

Table 76 Recommended Standards - Assurance

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

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Assurance Criterion #1 (Procedures)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	The AMC was developed specifically by EASA to cover the requirement. While still an NPA, the AMC will be published in Q1 of 2022.	10	No gaps identified
	High	Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021		12	
Assurance Criterion #2 (Training)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	ISO 23665 Unmanned aircraft systems -Training for personnel involved in UAS operations	The standard does not exhaustively cover ERP training requirements.	2	No gaps identified
		Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	A syllabus following the content of the AMC could cover the training criterion.	10	
	High	Partial	ISO 23665 Unmanned aircraft systems -Training for personnel involved in UAS operations	The standard does not exhaustively cover ERP training requirements.	2	
		Full	EASA AMC3 UAS.SPEC.030(3)(e) EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021	A syllabus following the content of the AMC could cover the training criterion.	12	

3.4 Tactical Mitigations Performance Requirements - VLOS

3.4.1 Requirement Description

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Table 77 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 78 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 79

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 80 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 81

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 82

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 83 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 84 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 85 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 86 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	d	P
	Decide		
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-386: 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 87

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
ASTM F3442 - Detect and Avoid performance Requirements	-	-	(P)	The document only provides the general requirements and needs complementation from other documents.
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. RTCA SC-147 is writing MOPS for ACAS sXu which is a reference architecture for the ASTM F3442/3442M-20 standard.				

Table 88

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.				

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Table 89

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
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 90

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.				

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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;
- 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.

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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.

Table 91

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	
	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:

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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.

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 92

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	

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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 93

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 94

Standard title	Function	Arc	Coverage (P-Partial coverage, F-Full coverage)	Gaps (Requirements not covered)
RTCA DO-386: 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 95

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[1] (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[2].

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

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

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Table 96

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 97

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 98

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 99 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 100

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 [6], 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 101

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 extends 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.

Furthermore, RTCA SC-147 is writing MOPS for ACAS sXu which is a reference architecture for the ASTM F3442/3442M-20 standard. The latter specification does not define a specific detect and avoid (DAA) architecture and is architecture agnostic. It will, however, define specific safety performance thresholds for a DAA system to meet to ensure safe operation. It applies to unmanned aircraft (UA) with a maximum dimension (for example, wingspan, disc diameter) ≤25 ft, operating at airspeeds below 100 kts, and of any configuration or category. It is meant to be applied in a “lower risk” airspace environment with assumed infrequent encounters with manned aircraft; this is typically in classes G and E airspace (below about 1200 ft above ground level (AGL)), Class B, C, D (below about 400 to 500 ft AGL).

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.

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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 a VLL. 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:
  - 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 102 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 defines technology independent requirements, and requires complementation by additional specifications.	6	Lack of standards (i.e. MOPS) on DAA for small drones. Lack of standards (i.e. MOPS) for

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	Arc-c	Partial	F3442 - Detect and Avoid performance Requirements	The document defines technology independent requirements, and requires complementation by additional specifications.	6	small drones above VLL.
	Arc-d	Partial	DO-365: MOPS for Detect and Avoid (DAA) Systems-Phases 1 and 2	Not applicable to all categories of drones (SWAP) Cost of compliance for small drones is estimated to be high	2	
			DO-366 Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance	**Not applicable to Decide, 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	
			RTCA DO-386: Minimum Operational Performance Standards for Airborne Collision Avoidance System Xu (ACAS Xu)	Integrates DAA Phase 1 and Phase 2 developed by RTCA	3	

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

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3.6.1 Requirement Description

Table 103 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. 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.*
	High	

Table 104Assurance 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

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Table 105 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
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744		P	P

Table 106 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

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Table 107

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 108

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			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 109

Standard Title	SDO	Doc. Reference	Criterion 1	Gaps

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

			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.						

Table 110

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 111

Standard Title	SDO	Doc. Reference	Criterion 1	Gaps

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

			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 112

Standard Title	SDO	Doc. Reference	Criterion 1			Gaps
			L	M	H	
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 113

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.

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

3.6.2.1 Summary

Table 114 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 115

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	There is no guideline or standard defining the minimum	Safety (3)	High	Each company should have a structure, consistent with the level of activities and business.	-1	-3

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1	requirements for organizations in terms of structure, post-holders, etc. for categories of operations.			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.		
		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

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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 116 Recommended Standards - Integrity

Integrity						
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 117 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 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	

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

For the standards applicable to OSO #02 refer to Part III of D4.3 (SC Light-UAS).

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

3.8.1 Requirement Description

Table 118 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.

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	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 119 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.
	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.

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	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 120 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				
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			

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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 121

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
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 122

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						

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Table 123

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	
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)						

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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

Table 124

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 125

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	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 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 126

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.
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)									

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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)	
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 127

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.									

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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

Table 128 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		5	

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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		4	
		Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		3	
		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		7	
			JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		5	
			MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		3	

Table 129 Recommended Standards – Assurance

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

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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		5	
		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		4	
		Full	A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		3	
		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		7	
			JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		5	
			MSG-3 - Operator/Manufacturer Scheduled Maintenance Development		3	

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Criterion 2 (Training)	Low	N/A	NO STANDARD REQUIRED			
	Medium	N/A	NO STANDARD REQUIRED	ISO 23665 could be used as guidance	4	
	High	Full	NCATT – Unmanned Aircraft System (UAS) Maintenance Standard		6	

3.9 *OSO 04* – UAS developed to authority recognised design standards

For the standards applicable to OSO #04 refer to Part III of D4.3 (SC Light-UAS).

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

For the standards applicable to OSO #05 refer to Part III of D4.3 (SC Light-UAS).

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

For the standards applicable to OSO #06 refer to Part III of D4.3 (SC Light-UAS).

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

3.12.1 Requirement Description

Table 130 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	

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	High	

Table 131 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.

3.12.2Summary

Table 132 OSO 7 Standards' effectiveness in fulfilling the requirement

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*		
			L	M	H	L	M	H
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	(P)	(P)	(P)	(P)	(P)	(P)
Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707				F	P	P
Standard for Small Unmanned Aircraft Systems (sUAS) Used for Public Safety Operations	NFPA	NFPA 2400	(P)	(P)	(P)	(P)	(P)	(P)

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Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*		
			L	M	H	L	M	H
Unmanned aircraft systems – Part 3: Operational procedures	ISO	21384-3	P	P	P			
Training for personnel involved in UAS operations	ISO	23665				F	F	P
Department of Defense Standard Practice System Safety	DoD	MIL-STD-882E						
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18						
Standard Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)	ASTM	F2908 – 18	P	P	P			
Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	ASTM	F2909 – 19	P	P	P			
Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)	ASTM	F3178 – 16						
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266 – 18				F	P	P

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3.12.3 Coverage Detail

Table 133

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
New Practice for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM	WK62744	(P)	(P)	(P)	(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.
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 134

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

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Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	SAE	ARP5707				F	P	P	Does not cover the integrity requirements. Does not cover procedure part of assurance requirements. Missing in training part of assurance requirements: • For Medium level of robustness: A training syllabus including a product inspection procedure is available. The operator provides competency-based, theoretical and practical training. • For High level of robustness: A competent third party validates the training syllabus and verifies the remote crew competencies.
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. This standard partly covers the training part of the assurance requirements and requires that pre-flight inspection is included as a training topic.									

Table 135

Standard Title	SDO		Criterion 1	Criterion 2	Gaps

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		Doc. Reference	L	M	H	L	M	H	
Standard for Small Unmanned Aircraft Systems (sUAS) used for Public Safety Operations	NFPA	NFPA 2400	(P)	(P)	(P)	(P)	(P)	(P)	The abstract is insufficient to precisely assess coverage. Potentially, it partially covers the requirements of OSO#7.
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 136

Standard Title	SDO	Doc. Reference		Criterion 1			Criterion 2			Gaps
				L	M	H	L	M	H	
Unmanned aircraft systems - Part 3: Operational procedures	ISO	21384-3		P	P	P				Does not cover training part of assurance requirements. Missing in procedure part of 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. • For High level of robustness: Product inspection is documented and accounts for the manufacturer's recommendations if available. The product inspection is validated by a competent third party.
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 137

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Training for personnel involved in UAS operations	ISO	23665				F	F	P	Does not cover the integrity requirements. Does not cover the procedure part of the assurance requirements. Missing in training part of assurance requirements: • For High level of robustness: A competent third party validates the training syllabus and verifies the remote crew competencies.
The purpose of this international standard is that personnel who are involved in UAS operations will receive appropriate education and obtain essential knowledge and skill. This document describes the procedures for training personnel who will be involved in the operation of unmanned aircraft. This document defines: a) Knowledge, skill, attitude and qualification criteria that are needed for UAS pilots and training organizations that provides training to candidates of UAS remote pilots and. Other personnel involved in UAS operations. b) Training curriculum and contents for specific learning courses. c) Qualification and confirmation criteria for the training organizations. d) The general procedures for providing training of UAS personnel. The standard provides training recommendations for UAS personnel. It requires the availability of reference material, and requires both theoretical and practical training on pre-flight inspection skills. This standard partly covers the training part of the assurance requirements.									

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Table 138

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Department of Defense Standard Practice System Safety	DoD Department of Defense	MIL-STD-882E							Does not cover the integrity requirements. Does not cover the training part of the assurance requirements. Does not cover the procedure part of the assurance requirements apart from that the standard could help identify product inspection items.
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.									

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Table 139

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Specification for Training and the Development of Training Manuals for the UAS Operator	ASTM	F3330 – 18							Does not cover the integrity requirements. Does not cover the procedure part of the assurance requirements. Does not cover the training part of the assurance requirements apart from that it defines the structure of the training manual ((but does not mention the specific content including product inspection).
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 defines the structure of the training manual (but does not mention the specific content including product inspection).									

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Table 140

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)	ASTM	F2908 – 18	P	P	P				Does not cover the integrity requirements. Does not cover the training part of the assurance requirements. Missing in procedure part of assurance requirements: • For Low level of robustness: Product documentation accounts for the manufacturer's recommendations if available. • For Medium level of robustness: Product documentation accounts for the manufacturer's recommendations if available. The product inspection is documented using checklists. • For High level of robustness: Product documentation accounts for the manufacturer's recommendations if available. The product inspection is documented using checklists. The product inspection is validated by a competent third party.

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Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
This specification provides the minimum requirements for an Unmanned Aircraft Flight Manual (UFM) for an unmanned aircraft system (UAS) designed, manufactured, and operated in the light UAS category as defined by a Civil Aviation Authority (CAA). Depending on the size and complexity of the UAS, an UFM may also contain the instruction for maintenance and continuing airworthiness for owner / operator authorized maintenance. This specification defines the UFM information that shall be provided by the manufacturer of a UAS as part of the initial sale or transfer to an end user. This standard allows product inspection instruction to be included in the UFM.									

Table 141

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	ASTM	F2909 – 19	P	P	P				This standard does not cover the integrity requirements. This standard does not cover the training part of the assurance requirements. Missing in procedure part of assurance requirements: • For High level of robustness: The product inspection is validated by a competent third party.

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Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
This specification establishes the standard practice for the maintenance and continued airworthiness of a lightweight unmanned aircraft system (UAS). The intended use for this specification is for civil aviation authority (CAA), self-, or third-party determinations of continued airworthiness for UAS. This specification provides the core requirements for continued airworthiness of lightweight UAS or for certain CAA operational approvals using risk-based categories, or both. This specification is intended to support aircraft developed in accordance with Specifications F2910, F3002, F3005 (these cover sUAS), and F3298 (covers lightweight UAS). This standard requires that the manufacturer should provide instructions for inspection items and intervals as defined in the UMM. In the absence of a manufacturer-provided inspection program, it is the responsibility of the owner/operator to develop their own inspection program. This standard provides a detailed checklist.									

Table 142

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)	ASTM	F3178 − 16							Does not cover the integrity requirements. Does not cover the assurance requirements.

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Standard Title	SDO	Doc. Reference	Criterion 1			Criterion 2			Gaps
			L	M	H	L	M	H	
This practice 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). This practice is intended to provide an understanding of the risk assessment process as a baseline standard for applicants of sUAS designs and operations covered under the "small" designation of a CAA kinetic energy spectrum and that are not generally designed with the rigorous design assurance standards that exist in more complex unmanned aircraft with higher kinetic energy characteristics. This standard does not cover the integrity requirements, but mentions as an example: • The pilot should check all connections before flight. This standard does not cover the assurance requirements, but mentions as examples: • An inspection and maintenance plan should be developed by the pilot to include both manufacturer recommendations and those actions responsive to the particular flight environment, mission, and pilot. • A pre-flight checklist should be prepared and followed by the pilot to assure that the electrical system is intact and functional.									

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Table 143

Standard Title	SDO	Doc. Reference	Criterion 1			Criterion			Gaps
			L	M	H	L	M	H	
Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	ASTM	F3266 – 18				F	P	P	Does not cover the integrity requirements. Does not cover the procedure part of the assurance requirements. Missing in training part of assurance requirements: • For Medium level of robustness: A training syllabus including a product inspection procedure is available. The operator provides competency-based, theoretical and practical training. • For High level of robustness: A competent third party validates the training syllabus and verifies the remote crew competencies.

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This guide is intended for two distinct readers: educators who wish to develop curricula and training courses and individual pilots wishing to raise their knowledge level for particular flight operations. The guide describes the knowledge, skills, and abilities required to safely operate unmanned aircraft for commercial purposes. A Civil Aviation Authority (CAA) may, at their discretion, use this guide to aid the development of existing or future regulations. This guide addresses powered fixed-wing, vertical-take-off and lift and rotorcraft UAS and not other potential unmanned aircraft categories (for example, glider, lighter-than-air, etc.).
This guide provides fundamental general knowledge, task performance and knowledge, and activities and functions for remote pilots of lightweight UAS (but not necessarily limited to UAs under 55 lb Gross Take Off Weight) or for certain CAA operational approvals using risk-based categories.
This guide can be used to evaluate a training course outline and syllabus to determine when its content includes the topics necessary for training individuals to be proficient and competent remote pilot personnel. Likewise, this guide may be used to evaluate an existing training program to see when it meets the requirements in this guide.
The purpose of this guide is to provide a standardized means of facilitating Remote Pilot training. The guide should be used by all individuals and agencies that train such persons.
This guide describes required education, training, and continuing professional development for those performing as professional remote pilot.

- This standard requires that pre-flight inspection procedures are part of the training program.

3.12.4 Gaps

Table 144 Gap Summary - OSO 7

Gap	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Absence of standards covering: The product inspection is validated by a competent third party.	14	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.	14	No need to develop a standard for this gap.

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3.12.4.1 Details

Table 145

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Absence of standards covering" The product inspection is validated by a competent third party.	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 product inspection. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	6
		Cost of compliance to the requirement with a lack standard (2)	Very low	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. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	4
		Environmental Impact (1)	Good	Without a specification of when a third party is considered competent, there is a risk that the third party overlooks missing elements in the product inspection that could have an effect on the environment. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	2
		Impact on EU Industry competitiveness (1)	Very positive	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. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	2
Total Weighted Score						**14**

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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 remote crew competencies.	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 the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	6
		Cost of compliance to the requirement with a lack standard (2)	Very low	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. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	4
		Environmental Impact (1)	Good	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 that could have an effect on the environment. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	2
		Impact on EU Industry competitiveness (1)	Very positive	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. However the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations, so there is no risk.	2	2
Total Weighted Score						**14**

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3.12.5 Conclusions and Recommendations

ISO 21384-3 covers the integrity requirements.

ISO 21384-3 also partly covers the procedure criterion of the assurance requirements, but ASTM F2909-19 has a broader partial coverage of the procedure criterion of the assurance requirements and is therefore the recommended standard.

- A standard that defines the competence of a third party that validates the product inspection is missing. However, the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations.

ISO 23655 partly covers the training part of the assurance requirements.

- A standard that defines the competence of a third party that validates the training syllabus and verifies the remote crew competencies is missing. However, the basic regulation and the Air Operations Regulations already contain elements on how to assess the competences of organisations.

The following ASTM standard has not yet been assessed because it is still under development. This could potentially form an alternative to the recommended standards:

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

Table 146 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	6
	Medium	Full	ISO 21384-3: Operational Procedures	It only provides high level guidance	none	6

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	High	Full	ISO 21384-3: Operational Procedures	It only provides high level guidance	none	6

Table 147 Recommended Standards - Assurance

Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Gaps**	**Score**
Criterion #1	Low	Full	ASTM F2909 – 19 Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems	This specification is intended to support aircraft developed in accordance with Specifications F2910, F3002, F3005 (these cover sUAS), and F3298 (covers lightweight UAS).	none	8
	Medium	Full			none	8
	High	Partial			The product inspection is validated by a competent third party.	8
Criterion #2	Low	Full	ISO 23665 – Training for personnel involved in UAS operations	It only provides high level guidance	none	6
	Medium	Full			none	6
	High	Partial			A competent third party validates the training syllabus and verifies the remote crew competencies.	6

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3.13 *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)

3.13.1 Requirement Description

Table 148 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 149 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.

3.13.2 Summary

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Table 150 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)								
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)	F							F	F
Assurance											
Unmanned aircraft systems -- Part 3: Operational procedures	ISO	21384-3		P	P						
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F						

Table 151 OSO 08, 11, 14, 21 Documents not available or under development

Standard Title	SDO	Doc. Reference	Notes

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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
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

3.13.3 Integrity Coverage Detail

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Table 152

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	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.										

Table 153

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*	Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L/M/H	L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)	F					F	F	
This AMC was developed by EASA specifically to show compliance to requirements regarding operational procedures.										

3.13.1 Assurance Coverage Detail

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Table 154

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.												

Table 155

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L/M/H			L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F							
This AMC was developed specifically to show compliance to requirements regarding operational procedures.												

3.13.2Gaps

No gaps identified.

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3.13.3 Conclusions and Recommendations

The new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for OSO 08/11/14/21, as well as the criteria regarding operational procedures of other OSOs. While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.

In addition, 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.
Furthermore, 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.

Table 156 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.	4	No gaps identified.
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	The AMC was developed specifically to cover OSO 08/11/14/21. It will be recognised by EASA once the NPA is published.	8	
	Low	N.A.	NO STANDARD REQUIRED			
	Medium	N.A.	NO STANDARD REQUIRED			

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Criterion #2 (Procedure complexity)	High	N.A.	NO STANDARD REQUIRED			
Criterion #3 (Consideration of Potential Human Error)	Low	N.A.	NO STANDARD REQUIRED			
	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.	2	No gaps identified
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	The AMC was developed specifically to cover OSO 08/11/14/21.	8	

Table 157 Recommended Standards - Assurance

Assurance						
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 gaps identified
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically by EASA to show compliance to the requirement. It will be recognised by EASA once the NPA is published.	8	

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	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.	2	
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically by EASA to show compliance to the requirement. It will be recognised by EASA once the NPA is published.	8	

3.14 *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

3.14.1 Requirement Description

Table 158 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 c. Airmanship and aviation safety d. Human performance limitations e. Meteorology f. Navigation/Charts
	Medium	

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	High	g. UA knowledge h. Operating procedures and is adequate for the operation.

Table 159 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

3.14.2 Summary

Table 160 OSO 0*9, 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
Recommendations for Remote Pilot Competency (RPC) for UAS Operations in category A (Open) and category B (Specific)	JARUS	N.A.	P	P	P
Assurance					

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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)

3.14.3 Integrity Coverage Detail

Table 161

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.
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"*.						

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Table 162

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.						

3.14.1 Assurance Coverage Detail

Table 163

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
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.						

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Table 164

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 165

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	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.						

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Table 166

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.						

3.14.2 Gaps

3.14.2.1 Summary

Table 167 Gap Summary - OSO 0*9*, *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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3.14.2.2 Details

Table 168

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.[3] 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[4]. At the same time, it is time consuming for oversight authorities to check skills and competencies.	-1	-2

[3] 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*".

[4] 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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		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 169

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
		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

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		Social Acceptance (1)	No Impact	No impact foreseen on social acceptance.	0	0
Total Weighted Score						**+6**

3.14.3 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). The document is 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 170 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.	8	Lack of standards covering training requirements for non-regulated professions (e.g. supporting personnel, payload operator, flight dispatcher etc.)

Table 171 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.	8	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.	8	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.

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

For the standards applicable to OSO #10/12 refer to Part III of D4.3 (SC Light-UAS).

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

3.16.1 Requirement Description

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Table 172 Integrity Requirements' Description

Criterion	Robustness	Description
Criteria	Low	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.
	Medium	
	High	

Table 173 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.

3.16.2 Summary

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Table 174 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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3.16.3 Integrity Coverage Detail

Table 175

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 176

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 177

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 178

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 179

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 180

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 181

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 182

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 183

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.						

3.16.1 Assurance Coverage Detail

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Table 184

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 185

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 186

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.						

3.16.2 Gaps

3.16.2.1 Summary

Table 187 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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3.16.2.2 Details

Table 188

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 189

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 190

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

3.16.3 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.

Roles and responsibilities:
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.

Assurance:
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 191 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	4	

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Table 192 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	4	

3.17 *OSO 16* – Multi crew coordination

3.17.1 Requirement Description

Table 193 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1 (Procedures)	Low	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,
	Medium	

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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 194 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[5]/M/H)
- CRM training for all persons involved in the mission (Criterion #2; M/H)

[5] 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).

3.17.2 Summary

Table 195 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	-	-
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F						

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3.17.3 Coverage Detail

Table 196

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F							
This AMC was developed by EASA specifically to show compliance to the criteria regarding operational procedures.												

Table 197

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 September 2021.
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).												

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Table 198

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).												

Table 199

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 September 2021.
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 200

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.

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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 201

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.
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 202

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 September 2021.
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).												

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Table 203

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).												

3.17.4 Gaps

3.17.4.1 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

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(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
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
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

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Table 204 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 robust and effective communication channels cover the assignment of tasks to the crew	-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 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.).

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Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
6	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.
7	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.

3.17.4.2 Details

Table 205

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. 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	0	0

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				be an extra burden when a 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 206

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 communications between crew members	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	Medium	With missing standards, operators need to start from scratch by thinking through their operation and how that	0	0

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		with a lack standard (2)		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		
		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 207

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 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	0	0

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				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 208

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 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

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		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 209

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

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Table 210

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
6	Absence of standards for the training syllabus for 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**

Table 211

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

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	theoretical and practical training of multi-crew coordination			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.		
		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**

3.17.5 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 procedure 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.

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However, the new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for criteria regarding operational procedures. While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.

It is recommended to develop standards covering:

- The devices for communication between persons involved in the mission
- 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 212 Recommended Standards

Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 Procedures	Low	N.A.	NO STANDARD REQUIRED			No gaps identified.
	Medium	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	The EASA AMC was developed specifically to show compliance to the criteria regarding operational procedures. It will be recognised by EASA once the NPA is published.	8	
	High					

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

3.18.1Requirement Description

Table 213 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	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 214 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.

	Medium	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.

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	High	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.

3.18.2 Summary

Table 215 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	

3.18.3 Integrity Coverage Detail

Table 216

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

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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 217

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.

3.18.4 Assurance Coverage Detail

Table 218

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.

3.18.5 Gaps

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3.18.5.1 Summary

Table 219 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.

3.18.5.2 Details

Table 220

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	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
		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

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Total Weighted Score	-10

Table 221

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

3.18.6 Conclusions and Recommendations

None of the existing 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). Further research is required in order to potentially identify aviation standards that can be used for a definition of FRMS and resting times for the crew.

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

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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 222 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.	

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

For the standards applicable to OSO #18 refer to Part III of D4.3 (SC Light-UAS).

3.19 OSO 19 – Safe Recovery from Human Error

3.19.1 Requirement Description

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Table 223 Integrity Requirement Descriptions'

Criterion	Robustness	Description
Criterion #1 (Procedures and checklists)	Low	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.
	Medium	
	High	
Criterion #2 (Training)	Low	The Remote Crew is trained to procedures and checklists. The Remote Crew receives Crew Resource Management (CRM) training.
	Medium	
	High	
Criterion #3 (UAS design)	Low	Systems detecting and/or recovering from human errors are developed to industry best practices.
	Medium	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.
	High	

Table 224 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.

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	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.

3.19.2 Summary

Table 225 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
Integrity											

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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			
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)				
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F						
Assurance											
Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	JARUS	N.A						F			
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)		F	F						

3.19.3 Integrity Coverage Detail

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Table 226

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 227

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.

Table 228

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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	
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 229

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

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

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 230

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 231

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 232

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 233

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

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

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 234

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC. 030(3)(e)		F	F							No gaps identified for procedural requirements. The other criteria are not covered.

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This AMC was developed by EASA specifically to show compliance to requirements regarding operational procedures.

3.19.4Assurance 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	
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.												

Table 235

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

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

OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC. 030(3)(e)		F	F							No gaps identified for procedural requirements. The other criteria are not covered.
This AMC was developed by EASA specifically to show compliance to requirements regarding operational procedures.												

3.19.5 Gaps

3.19.5.1 Summary

Table 236 Gap Summary - OSO 19

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.	-5	It is strongly recommended to fully develop a standard covering training for visual observers, mainly for safety reasons.

3.19.5.2 Details

Table 237

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	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,	-1	-3

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	essential to the management of the flight			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.[6] Currently a only a working draft exists WK62741 that covers the training for Visual Observers in generic situations.		
		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[7]. 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**

[6] 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*".

[7] 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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3.19.6 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 #2, Low, Medium and High Integrity. Criterion 2 can potentially be fully covered in the future with the development of the training material for Visual Observers, as mentioned in ASTM WK62741 or the new and upcoming editions of ISO 23665. These standards, 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. Criterion 1 is fully covered by the EASA AMC on operational procedures.

Criterion #3 of OSO #19 addresses the technical design of the systems detecting and/or recovering from human errors, and is addressed in Part III of D4.3 (SC Light-UAS).

Table 238 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	No gaps identified
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically by EASA to show compliance to operational requirements. It will be recognised by EASA once the NPA is published.	8	

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	High	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.	4	
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically by EASA to show compliance to operational requirements. It will be recognised by EASA once the NPA is published.	8	
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.
			ASTM F3266-18 Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	Covers training for the PIC only.	6	Lacks training for other remote crew members and misses human performance aspects.

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			ASTM F3379-20 Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	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 Standard Specification for Training and the Development of Training Manuals for the UAS Operator		2	Lacks HP considerations and training for other remote crew
			ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	Not specifically for Human error recovery, but generic training which mitigates human errors.	2	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.

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			ASTM F3266-18 Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement	Covers training for the PIC only.	6	Lacks training for other remote crew and misses human Performance aspects.
			ASTM F3379-20 Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement	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 Standard Specification for Training and the Development of Training Manuals for the UAS Operator		4	Lacks and training for other remote crew
			ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	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: Unmanned aircraft systems - Training for personnel involved in UAS operations	Not specifically for Human error recovery, but generic training which mitigates human errors.	4	Covers training for the PIC, yet lacks BVLOS considerations.

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	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.
			ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	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 Standard Specification for Training and the Development of Training Manuals for the UAS Operator		6	Lacks and training for other remote crew
			ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	Not specifically for Human error recovery, but generic training which mitigates human errors.	6	Covers training for the PIC yet lacks BVLOS considerations.
Criterion #3 (UAS design)	Low	N.A.	For criteria on technical design refer to Part III of D4.3 (SC Light-UAS)			
	Medium					
	High					

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Table 239 Recommended Standards -Assurance

Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #2 (Training)	Low	Covered in Table 238 above, together with Integrity as described in the conclusions.				
	Medium					
	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.	6	

3.20 OSO 20 – A Human Factors evaluation has been […] found appropriate for the mission

For the standards applicable to OSO #20 refer to Part III of D4.3 (SC Light-UAS).

3.21 *OSO 23* – Environmental conditions for safe operations defined […] and adhered to

3.21.1 Requirement Description

Table 240 Requirements' Description

Integrity Criterion	Robustness	Assurance description

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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 Training covers assessment of meteorological conditions	Low	Training is self-declared (with evidence available).
	Medium	• Training syllabus is available. • The operator provides competency-based, theoretical and practical training.

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	High	A competent third party: • Validates the training syllabus. • Verifies the remote crew competencies.

3.21.2 Summary

Table 241 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 /AN 507								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	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)					F	F			

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Table 242 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

3.21.3 Integrity Coverage Detail

Table 243

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/ AN 507								P		
Notes: DOC 1009 / AN 507 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 244

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 245

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 246

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	
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 247

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												

Table 248

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												

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3.21.1 Assurance Coverage Detail

Table 249

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								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 250

Standard Title	SDO	Doc. Reference	Robustness *Criterion 1*			Robustness *Criterion 2*			Robustness *Criterion 3*			Gaps
			L	M	H	L	M	H	L	M	H	
OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	EASA	AMC2 UAS.SPEC.030(3)(e)					F	F				No gaps identified
This AMC was developed specifically to show compliance to criteria regarding operational requirements.												

3.21.2 Gaps

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3.21.2.1 Summary

Table 251 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	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

3.21.2.2 Details

Table 252

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	-2	-2

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				environment only in extreme cases in case of accidents that can cause environmental pollution		
		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**

Table 253

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	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
		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

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Total Weighted Score	+2

3.21.3 Conclusions and Recommendations

Criterion #1 (Definition) from OSO 23 is not at all covered directly by any standard. A potential source for definitions of safe environmental conditions for drones could come from helicopter standards and requires further research.

The new EASA NPA of 09/2021 features an AMC specifically developed to show compliance to medium and high levels of robustness for the criteria regarding operational procedures, and hence is applicable and fully covers Criterion #2 (procedures). While still an NPA, the AMC will be released in Q1 of 2022, and hence will be immediately recognised by EASA.

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.

Table 254 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 environmental conditions for safe operations.
	Medium			NO STANDARD AVAILABLE	N.A.	
	High			NO STANDARD AVAILABLE	N.A.	
Criterion #2	Low	N.A.	NO STANDARD REQUIRED			

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[Procedures]	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	No gaps identified.
		Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically to cover criteria on operational procedures. It will be recognised by EASA once the NPA is published.	8	
	High	Full	AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS	This AMC was developed specifically to cover criteria on operational procedures. It will be recognised by EASA once the NPA is published.	8	
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.	7	
		Partial	DOC – 1009 /AN 507 - 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.
			ARP 5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	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.

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			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
			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.	2	High level and does not satisfy any assurance regarding the checks of 3rd party.
	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 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations	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.

3.22 *OSO 24* – UAS designed and qualified for adverse environmental conditions

For the standards applicable to OSO #24 refer to Part III of D4.3 (SC Light-UAS).

3.23 Adjacent Area/Airspace Considerations

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For the standards applicable to the Adjacent Area/Airspace Considerations refer to Part III of D4.3 (SC Light-UAS).

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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, while some have full coverage. Partial coverage implies 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 and hence may be too demanding for the UAS sector.
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**
     - *For the standards applicable to Criterion #1 (Technical Design) of the Tethered Case refer to Part III of D4.3 (SC Light-UAS)*
     - ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category
     - ISO 21384-3 Unmanned aircraft systems — Part 3: Operational procedures
     - EASA AMC2 UAS.SPEC.030(3)(e) - Application for an operational authorisation
   - **M2 – Effects of UA Impact Dynamics are Reduced**
     - *For the standards applicable to Criterion #1 (Technical Design) refer to Part III of D4.3 (SC Light-UAS)*
     - EASA AMC2 UAS.SPEC.030(3)(e) - Application for an operational authorisation
   - **M3 – An Emergency Response Plan is in place, operator validated and effective**
     - ISO 21384-3: Operational Procedures
     - AMC3 UAS.SPEC.030(3)(e): EMERGENCY RESPONSE PLAN (ERP) WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS of the EASA NPA 09/2021
     - ISO 23665: Unmanned Aircraft Systems – Training for personnel involved in UAS operations
   - **Tactical Mitigations Performance Requirements - VLOS**
     - F1583-95 (2019): Standard Practice for Communications Procedures – Phonetics
   - **Tactical Mitigations Performance Requirements - BVLOS**
     - F3442 - Detect and Avoid performance Requirements
     - DO-365: MOPS for Detect and Avoid (DAA) Systems - Phase 1

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  - 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)
  - RTCA DO-386: Minimum Operational Performance Standards for Airborne Collision Avoidance System Xu (ACAS Xu)
- **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**
  - *For the standards applicable to OSO #02 refer to Part III of D4.3 (SC Light-UAS)*
- **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)
  - A4A MSG-3 - Operator/Manufacturer Scheduled Maintenance Development
  - JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes
- **OSO #5 - UAS is designed considering systems safety and reliability**
  - *For the standards applicable to OSO #05 refer to Part III of D4.3 (SC Light-UAS)*
- **OSO #6 – C3 link characteristics appropriate for the operation**
  - *For the standards applicable to OSO #06 refer to Part III of D4.3 (SC Light-UAS)*
- **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
  - AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS
- **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
- **OSO #10,12 – Safe recovery from technical issues**
  - *For the standards applicable to OSO #10/12 refer to Part III of D4.3 (SC Light-UAS)*
- **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

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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
- 16803-2:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals
- 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
- EUROCAE Guidelines for the use of multi-GNSS solutions for UAS

- **OSO #16 – Multi-crew coordination**
  - AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS
- **OSO #17 – Remote crew is fit to operate**
  - No standards available
- **OSO #18 – Automatic protection of the flight envelope from human errors**
  - *For the standards applicable to OSO #18 refer to Part III of D4.3 (SC Light-UAS)*
- **OSO #19 – Safe recovery from Human Error**
  - *For the standards applicable to Criterion #3 (UAS Design) refer to Part III of D4.3 (SC Light-UAS)*
  - 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 - Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement
  - ASTM F3379-20 - Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement
  - ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations
  - ARP5707 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations
  - Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)
  - AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS
- **OSO #20 – A Human Factors evaluation has been performed and the Human-Machine Interface (HMI) found appropriate for the mission**
  - *For the standards applicable to OSO #20 refer to Part III of D4.3 (SC Light-UAS)*
- **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

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        - 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 - Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations
        - AMC2 UAS.SPEC.030(3)(e): OPERATIONAL PROCEDURES WITH MEDIUM AND HIGH LEVELS OF ROBUSTNESS
    - **OSO #24 – UAS designed and qualified for adverse environmental conditions**
        - *For the standards applicable to OSO #24 refer to Part III of D4.3 (SC Light-UAS)*
    - **Adjacent Area/Airspace Considerations**
        - *For the standards applicable to the Adjacent Area/Airspace Considerations refer to Part III of D4.3 (SC Light-UAS)*

Given the above, it is recommended that:

- 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 EASA 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] EASA (2021, COMMISSION IMPLEMENTING REGULATION (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space)
[3] EASA (2020, Special Condition for Light Unmanned Aircraft Systems – Medium Risk)
[4] AW-Drones (2019), D2.2: Methodology for the assessment of drone standards
[5] EASA (2017), Research Programme On Collision with Drones: Work Area 1 Final Report, Issue 4.0
[6] SJU (2016), SJU European Drones Outlook Study
[7] 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://docs.google.com/spreadsheets/d/11uESSLJR2ZoEfBbknuEUDDzZq1RFQ7WS

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