AW-Drones
Final recommendations for EASA

D5.6

AW-Drones

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AW-Drones

Abstract

SORA

This document presents the standards offering at least a partial coverage of the criteria set by the Specific Operations Risk Assessment methodology (SORA) as recommended by EASA as AMC to Article 11 of EU Regulation 947/2019 and which can be already recommended for actual use in the AMC due to their score, the gaps which prevent a complete coverage, recommendations to cover each gap and recommendations on regulatory aspects to be addressed.

In this document only already published standards are considered.

These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (SORA) document.

U-Space

This document presents the standards offering at least a partial coverage of the requirements for the four mandatory and two optional U-Space services as listed in Commission Implementing Regulation 2021/664 [9] and which are deemed suitable to support verification of conformity of the U-Space service due to their score, the gaps which prevent a complete coverage, recommendations to cover each gap and recommendations on regulatory aspects to be addressed.

These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (U-Space) document.

SC-Light UAS

This document presents the standards offering at least a partial coverage of the requirements of CS-Light UAS and which are recommended as a preferred MoC for SAIL III and IV of the related OSO(s) due to their score, and the gaps which prevent a complete coverage.

These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (SC-Light UAS) document.

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Executive Summary

Several studies and surveys conclude that having a comprehensive regulatory and standardisation framework could be a major booster for the drone related business.

The EU regulation is performance-based and comprises of legally binding 'hard rules' (i.e. legally-binding Commission Regulations), that contain high-level performance requirements. These 'hard rules' are supplemented by so called 'soft rules' with the Acceptable Means of Compliance (AMC) approved by the European Union Aviation Safety Agency EASA. These AMCs may refer to standards produced by Standard Development Organisations (SDOs).

In this context, the EU's Horizon 2020 Research and Innovation Program funded Project AW-Drones to support the European Union's drone regulations by identifying standards that EASA may accept as AMC in the perspective of the performance-based regulations on UAS, enabling safe, environmentally sound and reliable operations of drones in the European Union, and by identifying gaps in the available standards.

SORA

This document presents the standards offering at least a partial coverage of the criteria set by the Specific Operations Risk Assessment methodology (SORA) as recommended by EASA as AMC to Article 11 of EU Regulation 947/2019 and which can be already recommended for actual use in the AMC due to their score, the gaps which prevent a complete coverage, recommendations to fill the identified gaps and recommendations on regulatory aspects to be addressed.

In this document only already published standards are considered.

These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (SORA) document.

The assessment was carried out for all criteria stemming from the SORA methodology, including:
- Ground Risk Mitigations
- Tactical Mitigations Performance Requirements (TMPR)
- Operational Safety Objectives
- Adjacent Area/Airspace considerations

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

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

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It is recommended that:

- The maturity of the standards will be continuously monitored to update the assessment with newly published standards
- The coverage identified in this document is published by the project as the unique European Meta-Standard supporting the application of the SORA methodology for the specific category of operations.
- The European Commission, supported by EASA, should bring the gaps identified in section 3 to the attention of the European UAS Standard Coordination Group (EUSCG) to possibly initiate actions to fill the gap.

U-Space

This document presents the standards offering at least a partial coverage of the requirements for the four mandatory and two optional U-Space services as listed in Commission Implementing Regulation 2021/664 [9] and which are deemed suitable to support verification of conformity of the U-Space service due to their score, the gaps which prevent a complete coverage, recommendations to cover each gap and recommendations on regulatory aspects to be addressed.

These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (U-Space) document.

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

- In case of gaps preventing full coverage, or where no standards are identified to provide at least partial coverage, SDO's could discuss in the European UAS Standard Coordination Group (EUSCG) how to fill these.

- The previous paragraphs have assessed several standards with respect to the several individual services described in regulation 2021/664. No standard, however, has been identified which fully suits and individual service or the U-space regulation. In case standards are retained, they only cover a small portion of a service or are originally not designed to serve the purpose and adaption of the standards might be recommended.
- Further the assessment methodology based on the individual review of standards and services poses a risk of incompatibility and fragmentation. Exchange of information, given the digital nature of the UTM infrastructure, happens at all levels and with multiple stakeholders for all the different services. The individual services and the stakeholders providing the several services should be considered as one ecosystem and not on an individual basis. To ensure compatibility and avoid fragmentation, it's advised that future standardisation efforts consider a larger framework and scope i.e. a set of UTM services including their proposed data formats and exchange mechanisms.
- Therefore, as suggestion, it might be useful to work closer with the individual SDO's to better coordinate and align the needs for standardisation.

SC-Light UAS

This document presents the standards offering at least a partial coverage of the requirements of CS-Light UAS and which are recommended as a preferred MoC for SAIL III and IV of the related OSO(s) due to their score, and the gaps which prevent a complete coverage.

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These results are derived from the assessment of the standards as described in D4.3 AW-Drones Proposed Standard – 3rd iteration (SC-Light UAS) document.

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

- In case of gaps preventing full coverage, or where no standards are identified to provide at least partial coverage, SDO's could discuss in the European UAS Standard Coordination Group (EUSCG) how to fill these.

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1 Introduction

1.1 Standards' assessment in the context of AW-Drones

Several studies and surveys conclude that having a comprehensive regulatory and standardisation framework could be a major booster for the drone related business.

The EU regulation is performance-based and comprises of legally binding 'hard rules' (i.e. legally-binding Commission Regulations), that contain high-level performance requirements. These 'hard rules' are supplemented by so called 'soft rules' with the Acceptable Means of Compliance (AMC) approved by the European Union Aviation Safety Agency EASA. These AMCs may refer to standards produced by Standard Development Organisations (SDOs).

In this context, the EU's Horizon 2020 Research and Innovation Program funded Project AW-Drones to support the European Union's drone regulations by identifying standards that EASA may accept as AMC in the perspective of the performance-based regulations on UAS, enabling safe, environmentally sound and reliable operations of drones in the European Union, and by identifying gaps in the available standards.

1.2 AW-Drones work plan

1.2.1 AW Drones Work Plan for SORA

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 but currently lacks guidance on which technical standards the drone operators could use.
The third iteration of the project focused on integrating the second iteration's work on standards applicable to the SORA methodology.

1.2.2 AW Drones Work Plan for U-Space

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In collaboration with EASA, AW-drones drafted a work plan to identify and assess standards addressing U-space specific issues, for already existing standards and for standards that are still under development. The work plan distinguishes three main technical work packages (WP):

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

1.2.3 AW Drones Work Plan for SC-Light UAS

In collaboration with EASA, AW-drones drafted a work plan to identify and assess standards addressing the requirements of the Special Condition Light-UAS. The work plan distinguishes three main technical work packages (WP):

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

The first step of the assessment process was to map the requirements of SC-Light UAS with the corresponding SORA Operational Safety Objectives. The assessment of standards supporting SORA was in fact used as the starting point to identify suitable Means of Compliance for SC-Light UAS.

1.3 Purpose and scope of this document (SORA)

Purpose

Based on the assessment mentioned in section 1.2.1, for each SORA requirement (mitigation or objective) the list of standards which offer at least a partial coverage of the criteria and which can be already recommended for actual use in the AMC due to their global score, is provided.

Per standard a description of any limitations (e.g. a limited scope such as MTOM less than 25kg, only rotorcraft, etc.) is provided.

Per standard a global score considering the standard maturity, type of standard, cost of compliance, environmental impact, impact on EU industry competitiveness is provided. In Annex 1 the reader will find the rationale behind the global score assigned to each standard.

Per SORA requirement an indication, in the form of a gap description, of the aspects from the criteria that are not adequately covered by the standards. The case may arise in which multiple standards providing a partial coverage jointly provide full coverage, hence yielding no gaps.

Per gap a total weighted score is provided based on assessment criteria listed in [2] which are: effect of lack of standard on safety, cost of compliance, environmental impact and impact on EU industry competitiveness. The score per assessment criterion and its rationale, and recommendations on how to fill the identified gaps based on their score are provided.

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Finally recommendations on regulatory aspects to be addressed are given.

For the complete assessment, the reader can refer to the D4.3 AW-Drones Proposed Standard – 3rd iteration (SORA) document.

Scope

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

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

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

- The maturity of the standards is updated to the last assessment conducted. Only the standards already published are considered.
- AW-Drones partners did not have full access to all standards at the time of the assessment. A complete assessment is provided only for the standards with full access. For the others we provide a preliminary assessment based on the publicly available information. [1]

OSO #4 – 'UAS developed to authority recognized design standards' was not addressed because a more comprehensive analysis is needed in coordination with EASA.

It shall be emphasized that the assessment did not address the technical quality of the individual standards. It was assumed that each standard was adequate to fulfil the scope for which it was developed, and hence the assessment only evaluated the standard's capability to address the criteria.

The assessment covers known updates in the activity of the SDOs, as assessed in 2021/Q4.

1.4 Purpose and scope of this document (U-Space)

Purpose

Based on the assessment mentioned in section1.2.2, the identified standards which are deemed suitable to support verification of conformity of identified U-Space services and related airborne functions are provided.

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

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The gaps (i.e. the aspects from the U-Space services that are not adequately covered by the standards) are provided.

Finally conclusions and recommendations are provided.

For the complete assessment, the reader can refer to the D4.3 AW-Drones Proposed Standard – 3rd iteration (U-Space) document.

Scope

With respect to the U-Space services considered the assessment was limited to the 4 mandatory U-space services and two optional services as listed in Commission Implementing Regulation 2021/664. These services are subject to certification by the competent authority, plausibly because considered safety-critical. The considered 6 services are:

1. **Network identification service (NIS)**
    a. A network identification service should provide the identity of UAS operators and location of UAS during operations, and share relevant information with other U-space airspace users.
2. **Geo-awareness service (GAW)**
    a. A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services.
3. **(UAS) flight authorisation service (alias Flight Clearance Service – FAS or FCS)**
    a. A flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified flight authorisations within the same U-space airspace.
4. **Traffic information service (TIS)**
    a. A traffic information service should alert UAS operators about other air traffic that may be present in proximity to their UAS.
5. **Weather information service (WIS)**
    a. A weather information service should support the UAS operator during the flight planning and execution phases, as well as improve the performances of other U-space services provided in the U-space airspace.
6. **Conformance monitoring service (CMS)**
    a. A conformance monitoring service should provide real-time alerting of non-conformance with the granted flight authorisation and inform the UAS operators when deviating from it.

Draft International Standard (DIS) ISO 23629-12 lists 30 possible digital U-space services, categorised as safety-critical, safety-related or operation support. The additional 24 UTM (U-space) services listed in ISO DIS 23629-12 are out of scope of this document.

The assessment covers known updates in the activity of the SDOs, as assessed in 2021/Q4.

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1.5 Purpose and scope of this document (SC-Light UAS)

Purpose

Based on the assessment mentioned in section 1.2.3 for each requirement of the SC-Light UAS the standards that are recommended as a preferred MoC for SAIL III and IV of the related OSO(s) are provided.

Gaps in the coverage of the requirement by these standards for SAIL III and IV of the related OSO(s) are provided.

For the complete assessment, the reader can refer to the D4.3 AW-Drones Proposed Standard – 3rd iteration (SC-Light UAS) document.

Scope

The assessment is based on the Special Condition Light-UAS Medium Risk published by EASA in December 2020.

This assessment covers known updates in the activity of the SDOs, as assessed in 2021/Q4.

1.6 Structure of the document

This document has seven sections:

- Section 1 provides an introduction to AW Drones, defines the purpose and scope of the document, and presents the document structure.

- Section 2 provides for each SORA requirement an overview of the results related to the assessment of technical standards for their effectiveness to fulfil SORA criteria at each level of robustness. For each SORA requirement the following information is provided:
    - The description of the criteria as it was published in the AMC & GM to Commission Implementing Regulation (EU) 2019/947 [1];
    - The list of standards which offer at least a partial coverage of the criteria and which can be already recommended for actual use in the AMC due to their global score, including a description of any limitations.
    - A global score per standard. In Annex 1 the reader will find the rationale behind the global score assigned to each standard.
    - An indication, in the form of a gap description, of the aspects from the criteria that are not adequately covered by the standards.

- Section 3 provides per SORA requirement a summary (taken from section 2) of the standards already recommended for actual use in the AMC.

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- Section 4 provides for each SORA requirement an indication, in the form of a gap description, of the aspects from the criteria that are not adequately covered by the standards a gap description. Per gap the following information is provided:
    - A weighted score based on assessment criteria listed in [2] which are: effect of lack of standard on safety, cost of compliance, environmental impact and impact on EU industry competitiveness.
    - The score per criterion and its rationale.
    - Recommendations on how to fill the identified gap based on its score.

- Section 5 provides per SORA requirement a summary (taken from section 4) of the identified gaps , i.e. the aspects from criteria that are not adequately covered by the, their classification and their total weighted score.

- Section 6 provides for each of the identified U-Space services the identified standards which are deemed suitable to support verification of conformity of the U-Space service. For each U-Space service the following information is provided:
    - The list of standards which offer at least a partial coverage, including a description of any limitations.
    - A score per standard. In Annex V of D4.3 AW-Drones proposed standards – 3rd iteration (U-Space 1) the reader will find the rationale behind the score assigned to each standard.
    - The gaps (i.e. the aspects from the U-Space services that are not adequately covered by the standards) are provided.
    - Recommendations on how to fill the identified gaps.

Section 7 This section provides for each requirement of the SC-Light UAS the standards that are recommended as a preferred MoC for SAIL III and IV of the related OSO(s), and the gaps. For each requirement of the SC-Light UAS the following information is provided:

- The link of the requirement with the SORA Operational Safety Objective(s).
- The standards that are recommended as a preferred MoC for SAIL III and IV of these OSO(s).
- Gaps in the coverage of the requirement by these standards for SAIL III and IV of these OSO(s).

- Section 8 provides recommendations on regulatory aspects to be addressed based on the outcomes of sections 2 and 4.

- In Annex 1 the reader will find the rationale behind the global score assigned to each standard.

1.7 How to Read This Document

This section highlights the main features of the tables describing the assessment of each standard, as outlined in Sections 2, 4, 5, 6 and 7. It explains how the information is presented and how to effectively read the results presented.

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1.7.1 SORA criterion description table (section 2 SORA)

Each sub-section under section 2 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 table example

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

Criterion

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

Robustness

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

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

Description

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

1.7.2 Recommended standards table (section 2 SORA)

The final part of each sub-section under section 2 includes a table with the recommended standards for each criterion as defined in [1]. The table below provides an example of what these tables look like.

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Assurance						
Criteria	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1	Low/None Medium	Partial	ISO 21384-3: Operational Procedures	The document only provides high level guidance	10	The document does not provide a detailed syllabus
		Partial	ISO 21384-3: Operational Procedures	The document provides high level guidance	2	The document does not provide a detailed syllabus
	High	N/A	NO STANDARD AVAILABLE			

Figure 2 Recommended standards table example

A recommended standards table provides the standards that offer at least a partial coverage of the criteria for each level of robustness, and which can be already recommended for actual use in the AMC due to their global score, including a description of any limitations, their score and any associated gaps.

There are recommended standards table for the integrity requirements and for the assurance requirements.

The columns are divided as follows:

Criterion

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

Robustness

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

Coverage

Provides an indication of no, partial or full coverage of the criteria for each level of robustness. 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.

Recommended standard

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

Limitation / Notes

Provides a description of any limitations of the coverage (e.g. a limited scope such as MTOM less than 25kg, only rotorcraft, etc.).

Score

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Provides a score per standard. In Annex 1 the reader will find the rationale behind the score assigned to each standard.

Depending on the score, the following conclusions will be drawn:

- A standard that corresponds with a requirement and has a high score (i.e. 5 or more) is recommended as preferred AMC and highlighted in green. In case of partial coverage the gaps will be indicated.
- A standard that correspond with a requirement and has a medium score (i.e. between 0 and 5) is recommended as possible AMC and highlighted in yellow. These standards might have severe limitations in terms of scope, applicability or cost of compliance. Therefore they can be recommended but with a very limited scope.
- If there is no standard to be recommended, this is highlighted in red.

Gaps

Provides an indication, in the form of a gap description, of the aspects from the criteria that are not adequately covered by the standard.

1.7.1 Identified gaps and recommendations table (section 4 SORA)

Each sub-section under section 4 starts with a table that shows the identified gaps and recommendations. The table below provides an example of what these tables look like.

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

Figure 3 Identified gaps and recommendations table example

A identified gaps and recommendations table provides a description the gaps, their classification, their total weighted score and recommendations based on the total weighted score. The columns are divided as follows:

Gaps and Gap description

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

Classification

Provides an indication of the gap category. The gaps have been classified into three categories, to better highlight their nature:

- Procedures: Gaps that refer to specific instructions and protocols associated with UAS operations.

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

Total weighted score

Provides the total weighted score. A negative sign indicates that the gap is somehow critical and actions might be required to fill the gap, whereas a positive sign indicates that the need to develop additional guidance/standard is not evident.

Conclusion Recommendation

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

1.7.2 Gap score details table (section 4 SORA)

The final part of each sub-section under section 4 includes a table with scoring of the gaps. The table below provides an example of what these tables look like.

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	2	2

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				already contain elements on how to assess the competences of organisations, so there is no risk.		
Total Weighted Score						14

Figure 4 Gap score details table example

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

Gaps and Gap description

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

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 on the criterion (see [2] for a detailed description of the assessment methodology.

Rationale

Reasoning behind a result (see previous).

Score

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

Weighted score

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

Total weighted score

Provides the total weighted score. 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.

1.7.1 Gap summary table (section 5 SORA)

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Section 5 includes tables which provide a summary of the gaps. The table below provides an example of what these tables look like.

summary

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

Figure 5 Gap summary table example

A gap summary table provides a description the gap, their classification and their total weighted score The columns are divided as follows:

Mitigation / Objective

Identifies the SORA requirement

Gap Description

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

Classification

Provides an indication of the gap category. The gaps have been classified into three categories, to better highlight their nature:

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

Total weighted score

Provides the total weighted score. 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.

1.7.1 Requirements coverage and gaps table (section 6 U-Space)

Each sub-section under Section 6 includes a table with standards which are deemed suitable to support verification of conformity of the U-Space service. The table below provides an example of what these table looks like.

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Requirement	Coverage	Recommended standard	Score	Limitations/notes	Gaps
1. Provision of weather data before and during the flight	Partial	ISO CD 23629-7, Data model for spatial data	9	Contains data models for meteorological phenomena. Partially compliant with draft U-space regulations, because only defining which information should be exchanged, but not interfaces.	23629-7 should be complemented by 235629-9 specifying the interfaces to exchange the information, as necessary also for weather related data.

A requirements coverage and gaps table provides the standards that offer at least a partial coverage of a requirements for the U-Space service, their score, a description of any limitations and a description of its gaps. The columns are divided as follows:

Requirement

Provides a description of a U-Space service requirement.

Coverage

Provides an indication of no, partial or full coverage of the requirement.

Recommended standard

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

Score

Provides the score per standard. In Annex V of D4.3 AW-Drones proposed standards – 3rd iteration (U-Space 1) the reader will find the rationale behind the score assigned to each standard

Limitations / notes

Provides a description of any limitations of the coverage.

Gaps

Provides the gaps i.e. the aspects from the U-Space service requirements that are not adequately covered by the standard.

1.7.2 Gap description and recommendations table (section 6 U-Space)

Each sub-section under Section 6 includes a table a description of the gaps and recommendations. The table below provides an example of what these table looks like.

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Gap #	Gap Description	Conclusion Recommendation
1	No standard has been developed specifically for this purpose. Though no major gaps are identified using the complementary standards ED-269 and ISO 23639-7	The ED-269 data model has been put forward to describe the geo-zones though is lacking some nomenclature/features which should be added in a next iteration of the standard. Not clear which 'restriction type' will be used to describe a U-space geo-zone.

A gap descriptions and recommendations table a description of its gaps and recommendations. The columns are divided as follows:

Gap #

A number for identification of the gap

Gap description

Provides the gap i.e. the aspects from the U-Space service requirements that are not adequately covered by the standards

Conclusion Recommendation

Provides recommendations on how to fill the identified gaps.

1.7.1 Requirements coverage and gaps table (section 7 SC-Light UAS)

Each sub-section under Section 7 includes a table with standards that are recommended as a preferred MoC for SAIL III and IV of the OSO(s) linked to the applicable requirement of the SC-Light UAS. The table below provides an example of what these table looks like.

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III	Gaps for SAIL III	Recommended standards for SAIL IV	Gaps for SAIL IV

A requirements coverage and gaps table provides for a requirement of the SC-Light UAS the standards that are recommended as a preferred MoC for SAIL III and IV of the specified OSO(s), and the gaps. The columns are divided as follows:

SC Requirements

Provides the identification of the requirement of the SC-Light UAS

Link SORA OSO(s)

Provides the link of the requirement with the SORA Operational Safety Objective(s).

Recommended standards for SAIL III / IV

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Provides the standards that are recommended as a preferred MoC for SAIL III and IV of the OSO(s).

Gaps for SAIL III / IV

Provides the gaps in the coverage of the requirement by the standards for SAIL III and IV of the OSO(s).

1.8 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
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
C2	Command and Control Link
C3	Command, Control and Communication
CAA	Civil Aviation Authority
CD	Committee Draft
CERTH	Centre for Research & Technology Hellas
CISP	Common Information Service Provider
CMS	Conformance Monitoring Service
ConOps	Concept of Operations
CU	Command Unit
DAA	Detect and Avoid
DJI	DJI Europe B.V
DLR	German Aerospace Centre
DOC	Designated Operational Coverage
DoD	Department of Defence
DRI	Direct Remote Identification
EASA	European Union Aviation Safety Agency
EDPS	European Data Protection Supervisor
ERP	Emergency Response Plan
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
EUSCG	European Data Protection Supervisor
EVLOS	Extended Visual Line of Sight
FAA	Federal Aviation Administration
FAS	Flight Authorisation Service
FCS	Flight Clearance (alias authorisation) Service
FCU	Flight Control Unit
FSF-MED	Flight Safety Foundation – SE Europe
GAW	Geo-Awareness service

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GM	Guidance Material
GPS	Global Positioning Unit
GRC	Ground Risk Class
HMI	Human Machine Interface
HW	Hardware
IAI	Israel Aerospace Industries Ltd.
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
JARUS	Joint Authorities for Rulemaking of Unmanned Systems
MOPS	Minimum Operational Performance Specification
MS	Member State
MTOM	Maximum Take-Off Mass
NATO	North Atlantic Treaty Organization
NFPA	National Fire Protection Association
NIS	Network Identification Service
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 Developmment Organization
SORA	Specific Operations Risk Assessment
STANAG	Standardization Agreement
STD	Standard
SW	Software
TIS	Traffic Information Service
TMPR	Tactical Mitigations Performance Requirements
ToR	Terms of Reference
TRS	Tracking Service
TU Delft	Delft University of Technology
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UCS	UTM Communication Service
US	United States
USSP	U-space (alias UTM) service provider
UTM	UAS Traffic Management (equivalent to U-space)
VLOS	Visual Line of Sight
WG	Working Group
WIS	Weather Information Service
WP	Work Package

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2 SORA criteria coverage overview

In sections 1.1 to 2.23 for each SORA requirement (mitigation or objective) the list of standards which offer at least a partial coverage of the corresponding criteria and which can be already recommended for actual use in the AMC due to their global score, is provided.

Per standard a description of any limitations (e.g. a limited scope such as MTOM less than 25kg, only rotorcraft, etc.) is provided.

Per standard a global score considering the standard maturity, type of standard, cost of compliance, environmental impact, impact on EU industry competitiveness is provided. In Annex 1 the reader will find the rationale behind the global score assigned to each standard.

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 gaps and constraints (e.g. high cost for implementation, low maturity) 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 not currently covered by any standard.

Per SORA requirement an indication is preovided, in the form of a gap description, of the aspects from requirements that are not adequately covered by the standards. The case may arise in which multiple standards providing a partial coverage to the criterion jointly provide full coverage, hence yielding no gaps.

Only the standards already published are considered.

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2.1 *M1* – Strategic Mitigations for Ground Risk

2.1.1 Requirement Description – Non-Tethered Operations

Table 1 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
Criterion #2 (Evaluation of people at risk)	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).
	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.

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Table 2 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.

2.1.2 Requirement Description – Tethered Operations

Table 3 Integrity Requirements' Description – Tethered Operations

Criterion	Robustness	Description
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

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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 4 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.
	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.

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2.1.3 Conclusions and Recommendations

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.

Table 5 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	Full	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Section 9 covers technical standards of tethering cables and automatic winches.	2	
		Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	
	High	Full	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Section 9 covers technical standards of tethering cables and automatic winches.	2	
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	4	

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Table 6 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Non-tethered operation - Criterion #1 (Definition of the ground risk buffer)	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	N.A.	NO STANDARD REQUIRED	N/A		
Non-tethered operation - Criterion #2 (Evaluation of people at risk)	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	Partial	DGAC - AÉRONEFS CIRCULANT SANS PERSONNE A BORD : ACTIVITÉS PARTICULIÈRES Ed 1 rev 4	definition of populated area is some kind of "authorized data" but does not answer the other items required for Med robustness	1	No standard/guidance defining how to evaluate number of people at risk. For High robustness no guidance on the definition of real time data.
	High	N.A.	NO STANDARD AVAILABLE		N/A	
Tethered operation - Criterion #1 technical design	Low	N.A.	NO STANDARD REQUIRED	N/A		
	Medium	Partial	ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category	Section 7.6 possibly applicable but only for UAS manufactured according to the standard	4	
	Medium High	Full	ISO/WD 24356 General requirements for tethered unmanned aircraft system	Section 11 provides guidance on test purposes and content.	2	
	Low	N.A.	NO STANDARD REQUIRED	N/A		

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

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

2.2.1 Requirement Description

Table 7 Integrity Requirements' Description

Criterion	Robustness	Description

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Criterion #1 (Technical Design)	Low	Does not meet the “Medium” level criterion
	Medium	Ground risk buffer takes into consideration: • Effects of impact dynamics and post impact hazards are significantly reduced although it can be assumed that a fatality may still occur. • When applicable, in case of malfunctions, failures or any combinations thereof that may lead to a crash, the UAS contains all elements required for the activation of the mitigation. • When applicable, any failure or malfunction of the proposed mitigation itself (e.g. inadvertent activation) does not adversely affect the safety of the operation.
	High	Same as medium. In addition: • When applicable, the activation of the mitigation, is automated. • The effects of impact dynamics and post impact hazards are reduced to a level where it can be reasonably assumed that a fatality will not occur.
Criterion #2 (Procedures, if applicable)	Low	Any equipment used to reduce the effect of the UA impact dynamics are installed and maintained in accordance with manufacturer instructions.
	Medium	
	High	
Criterion #3 (Training, if applicable)	Low	Personnel responsible for the installation and maintenance of the measures proposed to reduce the effect of the UA impact dynamics are identified and trained by the applicant.
	Medium	
	High	

Table 8 Assurance Requirements’ Description

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

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AW DRONES

<table>
<tr><td rowspan="3">Criterion #2
(Procedures, if applicable)</td><td>Low</td><td>• 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</td></tr>
<tr><td>Medium</td><td>• 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.</td></tr>
<tr><td>High</td><td>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.</td></tr>
<tr><td rowspan="3">Criterion #3
(Training, if applicable)</td><td>Low</td><td>Training is self-declared (with evidence available).</td></tr>
<tr><td>Medium</td><td>• Training syllabus is available.
• The operator provides competency-based, theoretical and practical training.</td></tr>
<tr><td>High</td><td>• Training syllabus is validated by a competent third party.
• Remote crew competencies are verified by a competent third party</td></tr>
</table>

2.2.2 Conclusions and Recommendations

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

The gap for installation and maintenance personnel is expected to be covered by current ASTM developments (ASTM WK60659).

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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 9 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1 (Technical Design)	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	F3322-18: Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes	F3322-18 is a specification that defines design, manufacturing, and test requirements for the parachute system. It does not provide minimum requirements related to the ground impact effects as this will likely be dependent on the governing CAA. Requirements are included for	4	No standards for automated termination system activation and documents that explicitly address techniques for the reduction of the effects of

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	High	Partial		the type of procedures which are necessary but not on the development or format. Does not cover criteria to assess the ground impact effects versus the likelihood of a fatality. The Civil Aviation Authority (CAA) will likely define the safe energy levels or accept proposed levels by the applicant based on the operation.		impact dynamics and post impact hazards as required. No standards for contingency or emergency procedures containing means of reduction of ground impact.
Criterion #2 (Procedures, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standard defining procedures for installation and maintenance
Criterion #3 (Training, if applicable)	Low Medium High	N/A	NO STANDARDS AVAILABLE		N/A	No standards describing the training for ground impact measures

Table 10 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARD REQUIRED			

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

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

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2.3.1 Requirement Description

Table 11 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 12 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.

2.3.2 Conclusions and Recommendations

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 13 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		6	No gaps identified

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	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	The AMC was developed specifically by EASA to cover the requirement. While still an NPA, the AMC will be published in Q1 of 2022.	8	

Table 14 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
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.	6	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		8	
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.	6	

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	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.	8	

2.4 Tactical Mitigations Performance Requirements - VLOS

2.4.1 Requirement Description

Table 15 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.

2.4.2 Conclusions and Recommendations

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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 16 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.
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

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2.5 Tactical Mitigations Performance Requirements - BVLOS

2.5.1 Requirement Description

Table 17 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. 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

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		• 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. 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.

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	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
	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.

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	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 18 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 commercially available products. No quantitative analysis is required.	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. No quantitative analysis is required.	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.
Tactical Mitigation Assurance	No Assurance Required.	The operator is declaring that the Tactical Mitigation System and procedures will mitigate the risk of	The operator provides evidence that the tactical mitigation system will mitigate the risk of collisions	The evidence that the tactical mitigation system will mitigate the risk of collisions with manned

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		collisions with manned aircraft to an acceptable level.	with manned aircraft to an acceptable level.	aircraft to an acceptable level is verified by a competent third party.

2.5.2 Conclusions and Recommendations

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

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

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

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

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

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

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

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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. 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 19 Recommended Standards

Functions	Arc	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
All	Arc-a	N/A	NO STANDARDS REQUIRED			
	Arc-b	Partial	F3442 - Detect and Avoid performance Requirements	The document potentially covers the requirements however the full draft was not available to the consortium. It is advised to include WK62669 - Detect and Avoid Testing Requirements, which is still in the drafting phase.	6	Lack of standards (i.e. MOPS) on DAA for small drones. Lack of standards (i.e. MOPS) for

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	Arc-c	Partial	F3442 - Detect and Avoid performance Requirements	The document potentially covers the requirements however the full draft was not available to the consortium. It is advised to include WK62669 - Detect and Avoid Testing Requirements, which is still in the drafting phase.	6	small drones above VLL.
	Arc-d	Partial	DO-365: MOPS for Detect and Avoid (DAA) Systems-Phase 1	Not applicable to all categories of drones (SWAP) Cost of compliance for small drones is estimated to be high	2	
			DO-366 Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance VLL not covered	**Not applicable to Decide, Command and Execute Functions**	3	
			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	

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

2.6.1 Requirement Description

Table 20 Integrity Requirements' Description

Criterion	Robustness	Description

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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 High	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.*

Table 21Assurance 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.

2.6.2 Conclusions and Recommendations

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

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

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

Table 22 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 23 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3: Operational Procedures	It could be used as the basis for audit by ISO notified bodies	4	

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	High	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	

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

2.7.1 Requirement Description

Table 24 Integrity Requirements' Description

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

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	High	Same as Medium. In addition, the manufacturing procedures cover at least: • manufacturing processes, • personnel competence and qualification, • supplier control.

Table 25 Assurance Requirements' Description

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

2.7.2 Conclusions and Recommendations

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

Table 26 Recommended Standards

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

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Criterion #1	Low Medium	Partial	ASTM F3003-14: Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg.	5 (low) 7 (med)	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.
			ASTM F2911-14e1 Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg developed according to ASMT F2910.	5 (low)	
		Full	EN 9100:2018: Quality Management Systems – Requirements for Aviation, Space and Defence Organizations	No specific requirements related to UAS manufacturing procedures.	3 (low) 4 (med)	
			ASTM F2972-15: Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System	No specific requirements related to UAS manufacturing procedures.	5 (low) 7 (med)	
			ISO 9001:2015 Quality management systems – Requirements	Only high level guidance. No specific requirements related to UAS manufacturing procedures.	4 (low) 6 (med)	

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	High	Partial	ASTM F3003-14 - Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)	Only applicable to UAS with MTOM of less than 25 kg.	9	
		Full	ISO 9001:2015 Quality management systems – Requirements	Only high level guidance. No specific requirements related to UAS manufacturing procedures.	8	
			EN 9100:2018 Quality Management Systems - Requirements for Aviation, Space and Defence Organizations	No specific requirements related to UAS manufacturing procedures.	5	

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

2.8.1 Requirement Description

Table 27 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 28 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.

2.8.2 Conclusions and Recommendations

Table 29 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	
		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	

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		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 30 Recommended Standards – Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion 1	Low	Full	NO STANDARD REQUIRED	The following standards can be used as advisory material: ASTM F2909-19, ASTM 2483-18, ASTM F3366-19 and AC 107-2 Chapter 7.		
	Medium	Full	JAP(D)100C-22 - Guide to Developing and Sustaining Preventive Maintenance Programmes		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	
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	

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

2.9.1 Requirement Description

Table 31 Integrity Requirements' Description

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

Table 32 Assurance Requirements' Description

Criterion	Robustness	Description
	Low	A Functional Hazard Assessment and a design and installation appraisal that shows hazards are minimized are available.

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

2.9.2 Conclusions and Recommendations

Table 33 Recommended Standards - Integrity

Integrity						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		6	
			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		7	
	Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	Not covering the part related to “detection of single failures…”	9	No gap as the missing aspect will be covered in the next release
			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	
	High	Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	

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

Table 34 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		6	
			EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		7	
	Medium	Partial	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	Not covering the part related to “detection of single failures…”	9	No gap as the missing aspect will be covered

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		Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	
		Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft	These standards are intended for Manned Aviation, so adaptation would be needed.	4	
		Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft		6	
		Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment		4	
	High	Partial	ASTM F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft		4	
		Partial	ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft		6	
		Partial	SAE ARP4761A Guidelines And Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment		6	
		Partial	EUROCAE ED-279 Generic Functional Hazard Assessment (FHA) for UAS/RPAS		9	

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

2.10.1 Requirement Description

Table 35 Integrity Requirements' Description

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

Table 36 Assurance Requirements' Description

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

2.10.2 Conclusions and Recommendations

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

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

Table 37 Recommended Standards - Integrity

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

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

Table 38 Recommended Standards - Assurance

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

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

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

2.11.1 Requirement Description

Table 39 Integrity Requirements' Description

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

Table 40 Assurance Requirements' Description

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

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2.11.2 Conclusions and Recommendations

ISO 21384-3 covers the integrity requirements.

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

- 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, so there is no gap.

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, so there is no gap

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 41 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 42 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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2.12 *OSO 08, 11, 14, 21* Operational Procedures

2.12.1Requirement Description

Table 43 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…).
	Medium	Contingency/emergency procedures require manual control by the remote pilot when the UAS is usually automatically controlled.
	High	Operational procedures are simple.

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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 44 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.

2.12.2 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.

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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.

In addition, SAE is developing standards addressing specific operational procedures associated to specific-use cases such as night operations, power line inspections and aerial photography, possibly providing best practices ad hoc for such operations.

Table 45 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.	4	
Criterion #2 (Procedure complexity)	Low	N.A.	NO STANDARD REQUIRED			
	Medium	N.A.	NO STANDARD REQUIRED			
	High	N.A.	NO STANDARD REQUIRED			
	Low	N.A.	NO STANDARD REQUIRED			

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Criterion #3 (Consideration of Potential Human Error)	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.	4	

Table 46 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.	4	
	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.	4	

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

2.13.1 Requirement Description

Table 47 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 g. UA knowledge h. Operating procedures and is adequate for the operation.
	Medium	
	High	

Table 48 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

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

2.13.2 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 49 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 50 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.

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

2.14.1Requirement Description

Table 51 Integrity Requirements' Description

Criterion	Robustness	Description

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

Table 52 Assurance Requirements’ Description

Criterion	Robustness	Description
Criterion 1	Low	A design and installation appraisal is available. In particular, this appraisal shows that: • the design and installation features (independence, separation and redundancy) satisfy the low integrity criterion; • particular risks relevant to the ConOps (e.g. hail, ice, snow, electro-magnetic interference…) do not violate the independence claims, if any.
	Medium	Same as low. In addition, the level of integrity claimed is substantiated by analysis and/or test data with supporting evidence.

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	High	Same as medium. In addition, a competent third party validates the level of integrity claimed.

2.14.2 Conclusions and Recommendations

Table 53 Recommended Standards

Integrity/Assurance						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion	Low	Partial	ASTM F3309-21: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	6	Development error/process Risk Analysis
			F3230-20: Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft	This practice covers internationally accepted methods for conducting safety assessments of systems and equipment for “small” aircraft. This standard provides a similar process as ASTM F3309, which was found to be more applicable to the other robustnesses.	4	Development error/process Risk Analysis

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	Medium	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	8	Development error/process. Explicit Risk Analysis
	High	Partial	ASTM F3309: Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	The document covers the requirements for OSOs #10 and #12 providing Procedural Flowchart, Failure Condition Identification and Classification, Safety Objectives, Design and Installation Appraisal, Qualitative Analysis of Failure Conditions, Common Mode Analysis, Use of Similarity, and Documentation. This standard does not address development error which should be addressed through an appropriate methodology. This standard does not address particular risk analysis. Therefore, this standard is classified partial.	8	Development error/process Risk Analysis

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

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

2.15.1 Requirement Description

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Table 54 Integrity Requirements' Description

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

Table 55 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.

2.15.2 Conclusions and Recommendations

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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:

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

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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.
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.

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Table 56 Recommended Standards - Integrity

Integrity						
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	-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

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			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	

Table 57 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	

2.16 *OSO 16* – Multi crew coordination

2.16.1 Requirement Description

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Table 58 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, (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).*
	Medium	
	High	
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 59 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.

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Criterion	Robustness	Description
	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.
	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)

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- Multi crew coordination training (Criterion #2; L[2]/M/H)
- CRM training for all persons involved in the mission (Criterion #2; M/H)
- 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).

2.16.2 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.
The EASA AMC was developed specifically to show compliance to the criteria regarding operational procedures.
It is recommended to develop standards covering:

- The devices for communication between persons involved in the mission
- Flight tests or simulation to prove the adequacy of multi crew coordination
- Flight tests to prove de adequacy of multi crew coordination for the complete envelope
- 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.

[2] 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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Table 60 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.	4	
	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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2.17 *OSO 17* – Remote crew is fit to operate

2.17.1Requirement Description

Table 61 Integrity Requirements' Description

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

Table 62 Assurance Requirements' Description

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

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Effectiveness to fulfil the requirement	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.

	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.

2.17.2 Conclusions and Recommendations

None of the existent standards were found to fully cover the criterion on its highest robustness level, whereas they can be used separately to identify the individual segments that make up the total requirement. None of these standards was found to define or specify a Fatigue Risk Management System (FRMS). 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 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 63 Recommended Standards

Integrity/Assurance

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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.	

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

2.18.1 Requirement Description

Table 64 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion	Low	The UAS flight control system incorporates automatic protection of the flight envelope to prevent the remote pilot from making any single input under normal operating conditions that would cause the UA to exceed its flight envelope or prevent it from recovering in a timely fashion.
	Medium	

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	High	The UAS flight control system incorporates automatic protection of the flight envelope to ensure the UA remains within the flight envelope or ensures a timely recovery to the designed operational flight envelope following remote pilot error(s). (The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance.)

Table 65 Assurance Requirements' Description

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

2.18.2 Conclusions and Recommendations

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

Table 66 Recommended Standards

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

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

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

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

2.19 OSO 19 – Safe Recovery from Human Error

2.19.1 Requirement Description

Table 67 Integrity Requirement Descriptions'

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

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Table 68 Assurance Requirements' Description

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

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2.19.2 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 Robustness Integrity. Criterion 2 can potentially by fully covered in the future with the development of the training material for Visual Observers, as mentioned in ASTM WK62741. This standard, combined with JARUS Recommendation for RPC have the potential to cover fully all training requirements in the future, including those for safe recovery from Human Error. Criterion 1 is fully covered by the EASA AMC on operational procedures. To the best of our knowledge, no standard covering Criterion 3 (Design) currently exists. Standards for Systems detecting and/or recovering from human errors do not exist, the closest possible approach is through a good HMI, covered by OSO #20.

Table 69 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

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		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.	4	
	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.	4	
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	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	Covers basic training for Public Safety Remote Pilots but would need to comply with other docs such as F3330 or JARUS Recommendation to be able to operate UAS. Most likely such standard will have low use for low robustness since most PS operations are of medium or high robustness.	4	
			ASTM F3330 – 18		2	Lacks HP considerations and training for other remote crew
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors.	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.
			ASTM F3266-18	Covers training for the PIC only.	6	Lacks training for other remote crew and misses human Performance aspects.

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			ASTM F3379-20	Covers basic training for Public Safety Remote Pilots but would need to comply with other docs such as F3330 or JARUS Recommendation to be able to operate UAS. Most likely such standard will have low use for low robustness since most PS operations are of medium or high robustness.	4	
			ASTM F3330 – 18		4	Lacks and training for other remote crew
			ARP5707	This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) from manned aviation concepts. Assessed from the outline.	4	
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors.	4	Covers training for the PIC, yet lacks BVLOS considerations.
	High (Integrity and Assurance)		JARUS Recommendations for RPC	Covers in detail VLOS and BVLOS requirements, while It only includes training requirements for the Remote Pilot.	7	JARUS recommendation for RPC and ASTM WK62741 could potentially cover all aspects related to training to improve recovery following a human error, both for the Pilot in Command and the Visual Observer.

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			ARP5707	This document provides an approach to the development of training topics for pilots of Unmanned Aircraft Systems (UAS) from manned aviation concepts. Assessed from the outline.	6	
			ASTM F3330 – 18		6	Lacks and training for other remote crew
			ISO 23665	Not specifically for Human error recovery, but generic training which mitigates human errors.	6	Covers training for the PIC yet lacks BVLOS considerations.
Criterion #3 (UAS design)	Low	N.A.		NO STANDARD AVAILABLE	N.A.	Lack of best practices/standards addressing the design of systems to detect and/or recover from human errors.
	Medium	N.A.		NO STANDARD AVAILABLE	N.A.	
	High	N.A.		NO STANDARD AVAILABLE	N.A.	

Table 70 Recommended Standards -Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #2	Low	Covered in Table 69 above, together with Integrity as described in the conclusions.				
	Medium					

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(Training)	High	Full	Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)	For high robustness assurance, the JARUS GM covers fully how a RAE is defined and what are its tasks in relation to the entities it audits.	6	

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

2.20.1 Requirement Description

Table 71 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation.
	Medium	
	High	

Table 72 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	The applicant conducts a human factors evaluation of the UAS to determine if the HMI is appropriate for the mission. The HMI evaluation is based on inspection or Analyses.
	Medium	Same as Low but the HMI evaluation is based on demonstrations or simulations.

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	High	Same as Medium. In addition, EASA witnesses the HMI evaluation of the UAS and a competent third party witnesses the HMI evaluation of the possible electronic means used by the VO.

2.20.2 Conclusions and Recommendations

Table 73 Recommended Standards - Integrity

Integrity						
Criterion	**Robustness**	**Coverage**	**Recommended standard**	**Limitations/Notes**	**Score**	**Gaps**
Criterion #1	Low	Partial	STANAG 4671	No "holistic approach". Systems oriented (navigation, powerplant parameters…) and mainly focus on ergonomics and anthropometrics. Low focus on cognitive functions. For fixed wing only. Too much complex and expensive for low complexity applications.	1	
		Partial	STANAG 4703	STANAG 4703 covers the HMI aspects that must be designed to facilitate the safe accomplishment of the design missions in a more high-level approach (information layout, to the information readability in all external lighting conditions, to aural signals etc). Potentially too restrictive for low robustness. For fixed wing only.	1	
	Medium	Partial	STANAG 4671	Same as for Low. Maybe expensive for medium complexity applications.	3	

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		Partial	STANAG 4703	Same as for Low. Maybe expensive for medium complexity applications.	3	Covers high level aspects for control layout. For fixed wing only.
	High	Partial	STANAG 4671	Same as for Low. Not expensive for high complexity applications.	5	
		Partial	STANAG 4703	Same as for Low. Not expensive for high complexity applications.	5	Covers high level aspects for control layout

Table 74 Recommended Standards - Assurance

Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	Partial	SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	2	Not directly developed for UAS and might be difficult to directly asses UAS-related aspects

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	Medium	Partial	SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	4	Not directly developed for UAS and might be difficult to directly asses UAS-related aspects
	High	Partial	SESAR Human Performance Assessment (HPA)	The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, the HPA was thought to cover manned aviation concepts, as, such it may be difficult to deeply analyse some issues specific to drones using such methodology (such as BVLOS, E-VLOS considerations).	4	Not directly developed for UAS, and does not mention the 3rd party to assess the VO HMI, in addition to the competent authority that verifies the HF and HMI considerations for the PIC.

OSO 20 Integrity is covered partially by a STANAG 4671. During the second workshop with EASA, EASA experts presented their review of the NASA document “Human factors guidelines for unmanned aircraft systems” (Hobbs & Lyall, 2016) and “FMS for unmanned aerial systems: HMI issues and new interface solutions” (Damilano, Guglieri, Quagliotti, & Sale, 2012). The revision led to build a table of human factors challenges for UAS. Each challenge has been linked with the STANAG 4671 requirements to assess whether this standard allows to tackle the main HF challenges brought by UAS. Refer to the table below.

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Elements that may induce human factors challenges	Description of the human factor challenge	STANAG 4671 requirements that should cover the HF challenge
Reduced sensory cues	The pilot of an unmanned aircraft has no out-the-window view to assist with navigation, collision avoidance, or weather awareness. The absence of auditory, proprioceptive, and olfactory sensations may also make it more difficult to monitor the state of the aircraft and reduce situational awareness. Onboard cameras, where available, typically present the pilot with a monocular image covering a restricted field of view.	USAR.1704 Minimum UAS crew USAR.U1787 UAS automatic diagnostic and monitoring USAR.U1788 Degraded modes of operation warning USAR.U1827 Flightpath deviation warning USAR.U1829 UAS safety status indication
Control and communication via radio link	The UAS pilot must monitor and anticipate the quality of the control link and be prepared for link interruptions. Link latencies may make direct manual control difficult and may disrupt voice communications when these are relayed via the radio link.	USAR.U1611 Command and control data link latency USAR.U1607 Command and control data link performance and monitoring(e) USAR.U1613 Command and control data link loss strategy (c) USAR.U1728 Data link data display, warnings and indicators
Physical characteristics of the control station	Control stations increasingly resemble control rooms or office workstations more than a traditional cockpit. The relative spaciousness of many control stations enables additional information displays to be added easily and without the forethought that would be needed to add them to a cockpit. It may be difficult to enforce sterile cockpit procedures if the control station is housed in an office environment.	USAR.U1703 UAS crew workplace USAR.1704 Minimum UAS crew USAR.U1705 UAS crew work place lights USAR.U1721 Arrangement and visibility USAR.U1727 Electronic data display (a) USAR.U1728 Data link data display, warnings and indicators USAR.U1731 General USAR.U1732 Safety critical controls USAR.U1733 Conventional controls and indicators USAR.U1741 UCS flight controls USAR.U1785 Warning, caution and advisory information colour code USAR.U1787 UAS automatic diagnostic and monitoring USAR.U1788 Degraded modes of operation warning USAR.U1790 UAS mode of control indicator
Transfer of control during ongoing operations	Control of an unmanned aircraft may be transferred during ongoing operations between adjacent control consoles within a control station or between geographically separated control stations. Each transfer may involve a risk of mode errors, inconsistencies between control settings, or miscommunication.	USAR.U1707 Communication system USAR.U1881 UA handover between two UCS(a)(b)(e) USAR.U1883 Command and control of multiple UA USAR.U1885 UA handover within the same UAS control station(a)(b)(e) USAR.U1887 Multiple UA monitoring
Unconventional characteristics of unmanned	Ultra-long-endurance flights may be monotonous and aircraft fatiguing, and a single flight may require multiple transfers of control at crew shift changes. Loitering flight patterns and slow rates of climb and descent may present challenges for air traffic controllers. The pilot may be required to interact with systems not typical of manned aviation, such as electric propulsion, fuel cells, and catapult launch systems.	USAR.1704 Minimum UAS crew
Flight termination	We assume that a UAS will not be used to carry passengers. Therefore in an emergency, the UAS pilot may choose to destroy the aircraft by ditching or other means rather than attempt a landing that could present a risk to people or property on the ground.	USAR.U1412 Emergency recovery capability USAR.U1732 Safety critical controls
Different functions allocation between user and automation	The pilot of a conventional transport aircraft will generally have the ability to turn off or minimize the use of automated systems and transition to manual control of the aircraft, even if this is accomplished via fly-by-wire systems. A single UA can be able to operate with different level of automation, for example switching between manual, semiautomatic and full automatic modes. This fact increases the importance of a correct human–automation interaction, therefore HMI design shall consider the relative problems.	USAR.U1490 Automatic take-off system, automatic landing system(d) USAR.U1492 Manual abort function(a) USAR.U1494 Automatic taxi system(b) USAR.U1769 “Abort” control for automatic take-off system or automatic landing system
Widespread use of interfaces based on consumer products	Current control stations increasingly resemble office workstations, with keyboard, mouse, or trackball interface device, and interfaces operating on consumer computer software. Some control stations are housed entirely on a laptop computer. A control station that contains controls and displays sourced from diverse commercial off-the-shelf providers is likely to suffer from a lack of consistency and other integration issues.	USAR.1704 Minimum UAS crew USAR.U1721 Arrangement and visibility

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Functionally wise, and aside of the “unconventional characteristics of unmanned”, it seems therefore that STANAG 4671 has intended to cover all the human factors challenges brought UAS. However, three major areas of improvement are required:

- Area of improvement 1: Although presenting some requirements linked to flight crew interface (refer to the list analysed above), STANAG 4671 is not considered, as currently written, to sufficiently address human factors in a holistic approach. The current approach of STANAG 4671 is system oriented (navigation, powerplant parameters…) and furthermore mainly focus on ergonomics and anthropometrics. However, most of the human performance issues observed with modern systems and HMIs are related to cognitive ergonomics and usability matters.
- Area of improvement 2: The STANAG 4671 only covers the minimization of UA operator error (refer for instance to USAR.U1490(d)) but not the fact that the design should support the recovery following an error. Indeed, since UA operator error will occur, even with a well-trained and proficient UA operator operating well-designed UAS, the design must support the management of those errors to avoid any safety consequences. This deficiency shows therefore that OSO18 cannot thoroughly complied with by means of this standard.
- Area of improvement 3: The AMC associated to the functional requirements listed above are very limited or sometimes not existent (i.e.: USAR.U1703 UAS crew workplace). Besides, there is no AMC that is explaining the human factors process that should be followed thus letting too much variability in the industry practices. This deficiency reveals that OSO20 cannot be thoroughly fulfilled with this standard

Same considerations apply also to STANAG 4703, in addition several areas of human factors challenges seem not covered by the STANAG AEP83:
- Unconventional characteristics of unmanned
- Reliance on automation
- Reduced sensory cues.

OSO 20 Assurance is neither fully covered. The only partial cover is given by the HPA procedure, which can provide a good basis for the development of Assurance methods for HMI and HF. A potential standard that could cover this gap in the future is JAUS AS6040A HMI Service Set, which is currently under development and could not be assessed.

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

2.21.1 Requirement Description

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Table 75 Requirements' Description

Integrity Criterion	Robustness	Assurance description
Criterion #1 Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document	Low	The applicant declares that the required level of integrity has been achieved.
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation, inspection, design review or through operational experience.
	High	EASA validates the claimed level of integrity.
Criterion #2 Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple recording system	Low	• Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. The adequacy of the procedures and checklists is declared.
	Medium	• Procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • The adequacy of the procedures is proved through: ○ Dedicated flight tests, or ○ Simulation provided the simulation is proven valid for the intended purpose with positive results.
	High	Same as Medium. In addition: • Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. • The procedures, flight tests and simulations are validated by a competent third party.
Criterion #3	Low	Training is self-declared (with evidence available).

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Training covers assessment of meteorological conditions	Medium	• Training syllabus is available. • The operator provides competency-based, theoretical and practical training.
	High	A competent third party: • Validates the training syllabus. • Verifies the remote crew competencies.

2.21.2 Conclusions and Recommendations

The assessment of OSO #23- "Environmental conditions for safe operations defined, measurable and adhered to" at this stage can provide some conclusions. Given the context of OSO #23 the standards that are applicable and tend to have a wider coverage are more related to training and competence of pilots rather than other technical standards. Although they do indicate from their assessment that they have a coverage of OSO 23, many standards do not fully cover the requirements.

Table 76 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 [Procedures]	Low	N.A.	NO STANDARD REQUIRED			
	Medium	Partial	ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures	Generic standard which implies that the operator must operate under manufacturer-imposed weather limitations	2	No gaps identified.

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		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.	4	
	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.	4	
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	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.
			ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations	States that the training syllabus for UAS operators should include the knowledge of making local weather assessments	2	Too high level and generic

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			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	The document covers partially the medium level of robustness of Criterion #3 (training) by providing a guideline of what the syllabus for training UAS pilots should be. It covers meteorology and also flying with instrument flight rules covering also meteorology in this topic	4	Not mentioned that a competent 3rd party must validate the training.

Criterion #1 (Definition) from OSO 23 is not at all covered directly by any standard, possibly because the definition of potentially dangerous environmental conditions is covered indirectly by criterion #3 (Training). A potential source for definitions of safe environmental conditions for drones could come from helicopter standards and requires further research. For Criterion #2 (Procedures), only one standard covers partially procedures for evaluating safe meteorological procedures which are rather important. The absence of such environmental-related checklists represents a significant gap which should be covered in the near future. Criterion #3 (Training) is fully covered on the assurance side by JARUS Recommendation for RPC which mentions the meteorological situations that must be covered by training, but the actual details on how to recognize the dangers of such situations are missing (Integrity). Therefore, standards should identify the syllabus and the appropriate training that the UAS operators should undergo for assessing meteorological conditions.

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

2.22.1 Requirement Description

Table 77 Integrity Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	N/A
	Medium	The UAS is designed to limit the effect of environmental conditions.
	High	The UAS is designed using environmental standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. *National Aviation Authorities (NAAs) may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.*

Table 78 Assurance Requirements' Description

Criterion	Robustness	Description
Criterion #1	Low	N/A
	Medium	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience. *2 When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*
	High	EASA validates the claimed level of integrity.

2.22.2 Conclusions and Recommendations

The table below provides the recommended standards for OSO #24. No standards are required for a medium level of robustness, so the proposed standards may be used as guidance.

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Table 79 Recommended Standards

Integrity/Assurance						
Criterion	Robustness	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	Low	N/A	NO STANDARD REQUIRED			
	Medium	FULL, BUT NO STANDARD REQUIRED. THE FOLLOWING CAN BE USED AS GUIDANCE	UL 3030 – "Standard for Unmanned Aircraft Systems"	Recognized by Transport Canada (CAA) Document deals with Design of UAS <25kg and their intended operational spectrum (focused on electrical systems) and test methods for different conditions including adverse weather conditions Also covers the electrical shock, fire and explosion hazards associated with the inherent features of UASs, as well as the battery and charger system combinations provided for recharging the UAS	6	

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			IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	Standard applies to the classification of degrees of protection provided by enclosures for electrical equipment in general (not specific to UAS) with a rated voltage not exceeding 72,5 kV. Provides definitions for degrees of protection provided by enclosures of electrical equipment Provides designations for these degrees of protection including requirements for each designation Provides tests to be performed to verify that the enclosure meets the requirements of this standard	4	
			ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"	Document deals with Design of UAS <25kg and test methods for different conditions including adverse weather conditions (ie. Icing)	2	

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			EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"	covers all the requirements defined in the Annex of Commission delegated Regulation (EU) 2019/945 for each of the five classes of UAS (C0 -C4) below 25kg MTOM, with the exception of direct remote identification, geo-awareness and lighting describes appropriate technical solutions and verification methods to ensure and demonstrate the conformity of the UAS with these requirements	2	Only basic product requirements for UAS in "standard" environmental conditions
			EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"	Provides standard procedures and environmental test criteria for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the "jumbo jets" and SST categories of aircraft	2	The standard only addresses classical manned aviation aircrafts, Multi-rotor UA and remote-control station not covered
			JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	1	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
		Partial				

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			JARUS CS-LURS – “Certification Specification for Light Unmanned Rotorcraft Systems”	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	1	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
			NATO STANAG 4671 – “UAV System Airworthiness Requirements (USAR)”	Only for fixed wing military UAS with MTOM >150 kg < 20.000kg	1	Remote control station not covered
			NATO STANAG 4702 – “Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)”	Only for military rotary wing UAS	1	Remote Control station not covered
			NATO STANAG 4703 – “Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)”	Only for military fixed wing UAS	1	Remote Control station not covered

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	High	Partial	UL 3030 – "Standard for Unmanned Aircraft Systems"	Recognized by Transport Canada (CAA) Document deals with Design of UAS <25kg and their intended operational spectrum (focused on electrical systems) and test methods for different conditions including adverse weather conditions Also covers the electrical shock, fire and explosion hazards associated with the inherent features of UASs, as well as the battery and charger system combinations provided for recharging the UAS	8	
			IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"	Standard applies to the classification of degrees of protection provided by enclosures for electrical equipment in general (not specific to UAS) with a rated voltage not exceeding 72,5 kV. Provides definitions for degrees of protection provided by enclosures of electrical equipment Provides designations for these degrees of protection including requirements for each designation Provides tests to be performed to verify that the enclosure meets the requirements of this standard	6	

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			ASTM F3298-19 – “Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems”	Document deals with Design of UAS <25kg and test methods for different conditions including adverse weather conditions (ie. Icing)	4	
			EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment”	Provides standard procedures and environmental test criterion for testing airborne equipment for the entire spectrum of aircraft from light general aviation aircraft and helicopters through the “jumbo jets” and SST categories of aircraft	4	The standard only addresses classical manned aviation aircrafts, Multi-rotor UA and remote-control station not covered
			NATO STANAG 4671 – “UAV System Airworthiness Requirements (USAR)”	Only for fixed wing military UAS with MTOM >150 kg < 20.000kg	3	Remote control station not covered
			NATO STANAG 4702 – “Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)”	Only for military rotary wing UAS	3	Remote Control station not covered
			NATO STANAG 4703 – “Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)”	Only for military fixed wing UAS	3	Remote Control station not covered

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			JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	3	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
			JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"	Applicable to Light Unmanned Rotorcraft Systems with MTOM not exceeding 750 kg	3	Guidance needed to determine which subset of the proposed requirements should be used for each level of robustness
			EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"	covers all the requirements defined in the Annex of Commission delegated Regulation (EU) 2019/945 for each of the five classes of UAS (C0 -C4) below 25kg MTOM, with the exception of direct remote identification, geo-awareness and lighting. describes appropriate technical solutions and verification methods to ensure and demonstrate the conformity of the UAS with these requirements	3	Only basic product requirements for UAS in "standard" environmental conditions

2.23 Adjacent Area/Airspace Considerations

2.23.1 Requirement Description

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Table 80 Requirements' Description

Criterion	Applicability	Description
1	Always	No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume. Compliance with the requirement above shall be substantiated by a design and installation appraisal and shall minimally include: • design and installation features (independence, separation and redundancy); • any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the ConOps.
2	If adjacent areas are: 1. Gatherings of people unless already approved for operations over gathering of people OR 2. ARC-d unless the residual ARC is ARC-d In populated environments where: 1. M1 mitigation has been applied to lower the GRC 2. Operating in a controlled ground area	1. The probability of leaving the operational volume shall be less than 10-4/FH. 2. No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer. *Compliance with the requirements above shall be substantiated by analysis and/or test data with supporting evidence.* 3. Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could directly lead to operations outside of the ground risk buffer shall be developed to an industry standard or methodology recognized as adequate by the competent authority.

2.23.2 Conclusions and Recommendations

The available standards are generally covering adequately the criteria for adjacent area/airspace. There is only a lack of guidance for the Software Development assurance aspects for small COTS products, but this is expected to be covered by the standard under development within EUROCAE WG-117.

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Table 81 Recommended Standards

Criterion	Requirement	Coverage	Recommended standard	Limitations/Notes	Score	Gaps
Criterion #1	All	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)		9	
Criterion #2	1	Full	EUROCAE ED-270 MOPS Geocaging		9	
		Full	EUROCAE ED-269 MOPS Geofencing		9	
	2	Full	EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)	This standard is more suitable for small UAS	7	
			ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft	This standard is more suitable for larger UAS	6	
			SAE ARP4761A Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment	This standard is more suitable for larger UAS	4	
	3	Partial	RTCA/EUROCAE DO-254/ED-80 Design Assurance Guidance for Airborne Electronic Hardware	This standard might be too demanding for small UAS. It would provide Full coverage to the AEH part of the criterion.	6	There is a lack of standard for SW and AEH Development Assurance that are suitable for small UAS

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		Partial	EUROCAE/RTCA ED 12/DO-178 Software Considerations in Airborne Systems and Equipment Certification	This standard might be too demanding for small UAS. It would provide Full coverage to the SW part of the criterion	6	

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3 Summary of recommended standards (SORA)

In this section the standards already recommended for actual use in the AMC as specified in section 2 are summarised per SORA requirement:

- M1 – Strategic mitigations for Ground Risk - Non-tethered M1 mitigations
  - Methodology for the UAS Operational Risk for non-geographical flight permits – ENAC-LG 2017/001-NAV
  - DGAC - AÉRONEFS CIRCULANT SANS PERSONNE A BORD: ACTIVITÉS PARTICULIÈRES Ed 1 rev. 4
  - EUROCAE ED-270, Geocaging Appendix 1
- M1 – Strategic mitigations for Ground Risk - Tethered M1 mitigations
  - ASD-STAN prEN 4709 Aerospace series — Unmanned Aircraft Systems — Product requirements and verification for the Open category
  - ISO/FDIS 21384-3 Unmanned aircraft systems — Part 3: Operational procedures
- M2 – Effects of UA Impact Dynamics are Reduced
  - F3322-18 Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes
- M3 – An Emergency Response Plan is in place, operator validated and effective
  - ISO 21384-3: Operational Procedures
  - IATA Emergency Response Plan
- Tactical Mitigations Performance Requirements - VLOS
  - F1583-95 (2019): Standard Practice for Communications Procedures – Phonetics
- Tactical Mitigations Performance Requirements - BVLOS
  - DO-365: MOPS for Detect and Avoid (DAA) Systems - Phase 1
  - DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications
  - ED-258: Operational Services and Environment Description for DAA for DAA in Class D-G airspaces under VFR/IFR
  - ED-267: Operational Services and Environmental Description for DAA in Very Low-level Operations
  - DO-289: Minimum Aviation System Performance Standards for Aircraft Surveillance Applications
  - ED-271: MASPS for Detect & Avoid [Traffic] in Class A-C airspaces under IFR
  - DO-366: Minimum Operational Performance Standards (MOPS) for Air-to-Air Radar for Traffic Surveillance
  - ED-265: Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Satellite)
- OSO #1 – Operator competent and/or proven
  - ISO 21384-3 UAS – Part 3: Operational Procedures
  - F3178-16: Standard practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)

- ASTM F3364-19: Standard practice for independent audit program for unmanned aircraft operators
- OSO #2 – UAS manufactured by competent and/or proven entity
  - F2972 – 15 Standard Specification for Light Sport Aircraft Manufacturer's Quality Assurance System
  - F3003-14 Standard Specification for Quality Assurance of a Small Unmanned Aircraft System (sUAS)
  - ISO 9001:2015 Quality Management System
  - EN 9100:2018 Quality Management Systems - Requirements for Aviation, Space and Defence Organizations
  - ASTM F2911-14e1: Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS)
- OSO #3 – UAS maintained by competent and/or proven entity
  - ASTM F2909-19: Standard Specification for Continued Airworthiness of Lightweight Unmanned Systems
  - ASTM 2483-18: Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft
  - ASTM 3366-19: Standard Specification for General Maintenance Manual (GMM) for a Small Unmanned Aircraft System (sUAS)
- OSO #4 - UAS developed to authority recognized design standards
  - To be completed after coordination with EASA
- OSO #5 - UAS is designed considering systems safety and reliability
  - ASTM F3309 – Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
  - SAE ARP4761 – Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
  - EUROCAE ED-79 Guidelines for Development of Civil Aircraft and Systems
  - EUROCAE/RTCA ED-12C/DO-178 Software Considerations in Airborne Systems and Equipment Certification
  - EUROCAE/RTCA ED-80/DO-254 Design Assurance Guidance for Airborne Electronic Hardware
  - EUROCAE ED-280: Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
  - EUROCAE ED-279: Generic Functional Hazard Assessment (FHA) for UAS/RPAS
  - EUROCAE ED-79A Guidelines for Development of Civil Aircraft and Systems
  - ASTM F3230: Practice for Safety Assessment of Systems and Equipment in Small Aircraft
- OSO #6 – C3 link characteristics appropriate for the operation
  - ASTM F3002 – 14 - Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)
  - IEEE 802.11, IEEE 802.11a – WIFI technology (2.4 GHz + 5 GHz Band)
  - IEEE 802.15.1 – Bluetooth technology
  - IEEE 802.22 - Wireless regional area network (WRAN)
  - 3GPP - TR 36.777 Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles
  - EUROCAE ED-266 - Guidance on Spectrum Access, Use and Management for UAS

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        - RTCA DO-362 - Command and Control (C2) Data Link Minimum Operational Performance Standard (MOPS) (Terrestrial)
        - EUROCAE ED-265 - Minimum Operational Performance Standard for RPAS Command and Control Data Link (C-Band Satellite)
    - OSO #7 – Inspection of the UAS (product inspection) to ensure consistency to the ConOps
        - ISO 21384-3: Operational Procedures
        - ISO 23665 – Training for personnel involved in UAS operations
    - OSO #08, 11, 14, 21 – Operational Procedures
        - ISO 21384-3: Operational Procedures
    - OSO #09, 15, 22 - Remote Crew Competencies
        - F3330-18: Standard specification for Training and the Development of Training Manuals for the UAS Operator
        - JARUS Recommendations for RPC
        - ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations
        - ISO 23665 - Unmanned Aircraft Systems training for personnel involved in UAS operations
    - OSO #10,12 – Safe recovery from technical issues
        - ASTM F3309 – Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
        - F3230-17: Standard Practice for Safety Assessment of Systems and Equipment in Small Aircraft
        - ED-79A/ARP4754A: Guidelines for Development of Civil Aircraft and Systems
        - ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
    - OSO #13 – External services supporting UAS operations are adequate to the operation
        - ISO 21384-3 - Unmanned aircraft systems -- Part 3: Operational procedures
        - ISO 21384-2 - Unmanned aircraft systems -- Part 2: Product systems
        - 16803-1:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part1- Definitions and system engineering procedures for the establishment and assessment of performance
        - 16803-2:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems- Part2- Assessment of basic performances of GNSS-based positioning terminals
        - Resolución de 8 de marzo de 2019, de la Dirección de la Agencia Estatal de Seguridad Aérea, por la que se publican los medios aceptables de cumplimiento y material guía, aprobados para las operaciones con aeronaves pilotadas por control remoto, en virtud del Real Decreto 1036/2017, de 15 de diciembre.
        - ISO 23629-12 - Requirements for UTM services and service providers
    - OSO #16 – Multi-crew coordination
        - No appropriate standard available yet or available for review
    - OSO #17 – Remote crew is fit to operate
        - ISO 21384-3 UAS – Part 3: Operational Procedures
    - OSO #18 – Automatic protection of the flight envelope from human errors
        - STANAG 4671 – UAV System Airworthiness Requirements (USA)
        - STANAG 4703 – Light Unmanned Aircraft Systems Airworthiness Requirements

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    - JARUS – Certification Specification for Light Unmanned Rotorcraft Systems (CS-LURS)
    - JARUS – Certification Specification for Light Unmanned Aeroplane Systems (CS-LUAS)
- OSO #19 – Safe recovery from Human Error
    - ISO 21384-3 UAS – Part 3: Operational Procedures
    - F3330-18: Standard specification for Training and the Development of Training Manuals for the UAS Operator
    - JARUS Recommendations for RPC
    - ASTM F3266-18
    - ASTM F3379-20
    - ISO 23665
    - ARP5707
    - Guidance Material (GM) to JARUS RECOMMENDATION UAS RPC CAT A and CAT B regarding Recognized Assessment Entity (RAE)
- OSO #20 – A Human Factors evaluation has been performed and the Human-Machine Interface (HMI) found appropriate for the mission
    - UAV System Airworthiness Requirements (USAR) - UAS GCS Human systems Integration (HSI) Guidance and Human Factors (HF) Airworthiness considerations (based on STANAG 4671) – DRDC
    - STANAG 4703
    - SESAR Human Performance Assessment (HPA)
- OSO #23 - Environmental conditions for safe operations defined, measurable and adhered to
    - ISO 21384-3 Unmanned aircraft systems -- Part 3: Operational procedures
    - F3330 – 18 Standard Specification for Training and the Development of Training Manuals for the UAS Operator
    - Recommendations for remote PILOT COMPETENCY (RPC) for UAS OPERATIONS in category A (OPEN) and category b (specific)
    - DOC - 1009 - Manual on Remotely Piloted Aircraft Systems (PSURs)
    - ISO 23665: Unmanned aircraft systems - Training for personnel involved in UAS operations
    - ARP 5707
- OSO #24 – UAS designed and qualified for adverse environmental conditions
    - JARUS CS-LURS – "Certification Specification for Light Unmanned Rotorcraft Systems"
    - JARUS CS LUAS – "Certification Specification for Light Unmanned Aeroplane Systems"
    - ASTM F3298-19 – "Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems"
    - UL 3030 – "Standard for Unmanned Aircraft Systems"
    - IEC 60529 – "Degrees of protection provided by enclosures (IP Code)"
    - RTCA DO-160 – "Environmental Conditions and Test Procedures for Airborne Equipment"
    - EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"

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- NATO STANAG 4701 – "UAV System Airworthiness Requirements (USAR)"
- NATO STANAG 4702 – "Rotary Wing Unmanned Aerial Systems Airworthiness Requirements (AEP-80)"
- NATO STANAG 4703 – "Light Unmanned Aircraft Systems Airworthiness Requirements (AEP-83)"
- EUROCAE ED-14G / RTCA DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment"
- EN4709-001 – "Unmanned Aircraft Systems (UAS) - Product requirements"

- Adjacent Area/Airspace Considerations
  - EUROCAE ED-270 MOPS Geocaging
  - EUROCAE ED-269 MOPS Geofencing
  - EUROCAE ED-280 Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
  - ASTM F3309 Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
  - SAE ARP4761A Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
  - RTCA/EUROCAE DO-254/ED-80 Design Assurance Guidance for Airborne Electronic Hardware

EUROCAE/RTCA ED 12/DO-178 Software Considerations in Airborne Systems and Equipment Certification

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4 Identified gaps (SORA) and recommendations to fill the gaps

In sections 4.1 to 4.23 for each SORA requirement an overview is given of the identified gas, i.e. the aspects from criteria that are not adequately covered by the standards. The case may arise in which multiple standards providing a partial coverage to the criterion jointly provide full coverage, hence yielding no gaps.

Per gap a weighted score is provided based on assessment criteria listed in [2] which are: effect of lack of standard on safety, cost of compliance, environmental impact and impact on EU industry competitiveness.

The score per criterion and its rationale, and recommendations on how to fill the identified gaps based on their score are provided.

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

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

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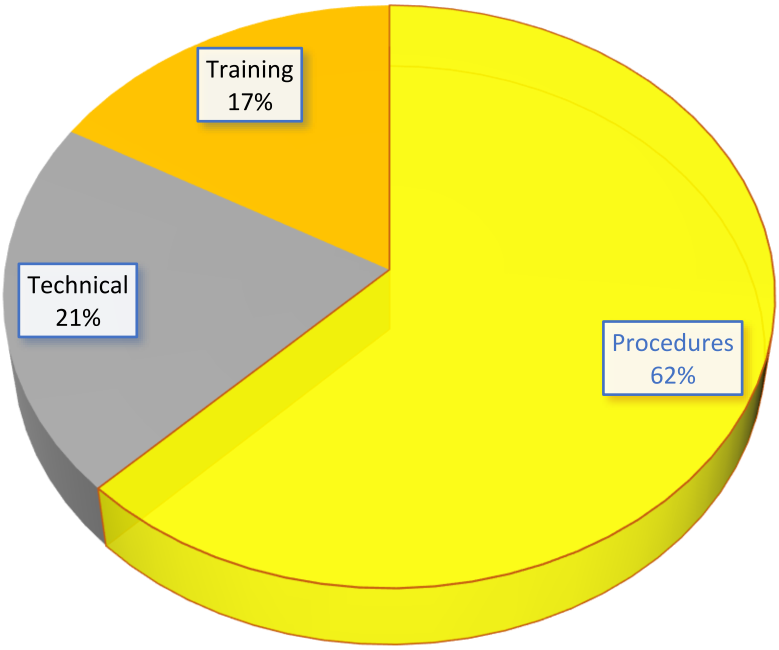

Figure 6 Overview of gaps identified

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4.1 *M1* – Strategic Mitigations for Ground Risk

4.1.1 Identified gaps and recommendations

Table 82 Identifed gaps and recommendations – M1

Gap #	Gap Description	Classification	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).	Procedures	-6	It is recommended to develop dedicated guidance and standards, where relevant, to support operators in complying with the requirements of M1.

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	• 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.			

4.1.2 Gaps score details

Table 83 Gap score details – M1

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

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		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**

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

4.2.1 Identified gaps and recommendations

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Table 84 Identifed gaps and recommendations – M2

Gap #	Gap Description	Classification	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.	Procedures	-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	Procedures	-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	Training	+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	Procedures	+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.

4.2.2 Gaps score details

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Table 85 Gap score details – M2

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

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Total Weighted Score	**-6**

Table 86 Gap score details – M2

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

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Table 87 Gap score details- M2

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**

Table 88 Gap score details- M2

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

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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**

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

4.3.1 Identified gaps and recommendations

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

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4.4 Tactical Mitigations Performance Requirements - VLOS

4.4.1 Identified gaps and recommendations

Table 89 Identifed gaps and recommendations – Tactical Mitigations - VLOS

Gap #	Gap Description	Classification	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.	Procedures	-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.
2	There is no existing guidance to develop the procedures and protocols in support of a VLOS de-confliction scheme.	Procedures	-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.

4.4.2 Gaps score Details

Table 90 Gap score details – Tactical Mitigations - VLOS

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

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

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 91 Gap score details – Tactical Mitigations - VLOS

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

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		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
Total Weighted Score						-4

4.5 Tactical Mitigations Performance Requirements - BVLOS

4.5.1 Identified gaps and recommendations

Table 92 Identifed gaps and recommendations – Tactical Mitigations - BVLOS

Gap #	Gap Description	Classification	Total Weighted Score	Conclusion Recommendation
1	Lack of standards (i.e. MOPS) on DAA for small drones.	Technical	-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.	Technical	-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.

4.5.2 Gap score details

Table 93 Gap score details - – Tactical Mitigations - VLOS

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

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		Environmental Impact (1)	Bad	DAA concept for VLL may deal with avoidance of wildlife or protected areas.	-2	-2
		Impact on EU Industry competitiveness (1)	Negative	As outlined in [4], European players are expected to play a key role in developing and commercialising drone technologies compatible with future airspace management requirements, including detect and avoid technology.	-1	-1
		Social Acceptance (1)	No impact	Until reliable DAA solutions are developed, certain types of operations will not be authorised by Authorities, but no particular societal concern is expected.	0	0
Total Weighted Score						**-11**

Table 94 Gap score details – Tactical Mitigations - VLOS

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

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		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

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

4.6.1 Identified gaps and recommendations

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Table 95 Identifed gaps and recommendations - OSO 01

Gap #	Gap Description	Classification	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.	Procedures	-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.

4.6.2 Gap score details

Table 96 Gap score details – OSO 01

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.	Safety (3)	High	Each company should have a structure, consistent with the level of activities and business. The aviation companies should have a structure with, as minimum, specific job positions for operational, logistic and safety matters.	-1	-3

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1				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

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Total Weighted Score	-4

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

4.7.1 Identified gaps and recommendations

Table 97 Identifed gaps and recommendations - OSO 02

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

4.7.2 Gaps score details

Table 98 Gap score details - OSO 02

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

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

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

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4.8.1 Gaps summary

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.

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

4.9.1 Identified gaps and recommendations

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

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

4.10.1 Identified gaps and recommendations

Table 99 Identifed gaps and recommendations - OSO 06

Gap	Gap Description	Classification	Total Weighted Score	Conclusion Recommendation

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

4.10.2Gaps score details

Table 100 Gap score details – OSO 06

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

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		Impact on EU Industry competitiveness (1)	Negative	The EU industry competitiveness can be negatively impacted due to the lack of common requirements/procedures for UAS Communication.	-1	-1
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-4**

4.11 *OSO 07* – Inspection of the UAS [...] to ensure consistency to the ConOps

4.11.1 Identified gaps and recommendations

Table 101 Identifed gaps and recommendations - OSO 07

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

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4.11.2 Gaps score details

Table 102 Gap score details – OSO 07

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

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		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**

Table 103 Gap score details – OSO 07

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

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		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

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Total Weighted Score	**14**

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

4.12.1 Identified gaps and recommendations

No gaps identified.

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

4.13.1 Identified gaps and recommendations

Table 104 Identifed gaps and recommendations - 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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4.13.2 Gaps score details

Table 105 Gap score details - OSO 09, *15, 22*

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

[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*".

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		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
		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**

[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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Table 106 Gap score details - OSO 09, *15, 22*

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**

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

4.14.1 Identified gaps and recommendations

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

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

4.15.1 Identified gaps and recommendations

Table 107 Identifed gaps and recommendations - 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	-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

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	performance adequacy specifically for drone operations.		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.

4.15.2Gaps score details

Table 108 Gap score details – OSO 13

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	-2	-6

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				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.		
		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
		Environmental Impact (1)	Bad	The use of GNSS contributes to reduce traffic congestion and improve the efficiency of transportation through navigation, fleet	-2	-2

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				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.		
		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	-2	-2

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				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.		
		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. 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.	1	1
Total Weighted Score						**-11**

Table 109 Gap score details – OSO 13

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	Lack of standardised procedures for the	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	1	3

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2	monitoring of external services			by most commercial drones to allow a safe recovery of the UAS.		
		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**

Table 110 Gap score details – OSO 13

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
	Lack of testing procedures to demonstrate that GNSS	Safety (3)	High	For high assurance it is required to demsontrate somehow that the desired performance level is	-1	-3

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3	performance is adequate for UAS OPS.			achieved. The absence of standard procedures might lead operators to perform inaccurate or incomplete tests.		
		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**

4.16 *OSO 16* – Multi crew coordination

4.16.1 Identified gaps and recommendations

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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)	?	-	?	-	?	-	?	1- Absence of standards for the procedure(s) to ensure coordination 2 - between the crew members and robust and effective communication channels cover the assignment of tasks to the crew
(Procedure(s) to ensure coordination between the crew members and robust and effective communication channels cover the) step-by-step communications between crew members (Criterion 1; L/M/H)	?	-	?	-	?	-	?	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
Multi crew coordination training (Criterion 2; L/M/H)	?	-	?	?	?	?	-	3- Absence of standards for multi crew coordination training

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CRM training for all persons involved in the mission (Criterion 2; M/H)	?	-	?	?	?	?	-	4 - 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)	-	?	?	-	?	-	-	5 - Absence of standards for the devices for communication between persons involved in the mission
Training syllabus for multi-crew coordination (Criterion 2; M)	?	-	?	?	?	?	?	6- Absence of standards for the training syllabus for multi-crew coordination
Competency-based theoretical and practical training of multi-crew coordination (Criterion 2; M)	?	-	?	?	?	?	?	7 -Absence of standards for competency-based theoretical and practical training of multi-crew coordination

* Could not be assessed because under development

** Could not assessed because only a summary available

Table 111 Identifed gaps and recommendations - 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	-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

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Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
	communication channels cover the assignment of tasks to the crew		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

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Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
			members, ability of crew member to use/activate a communication device, need for full duplex communication, etc.).
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.

4.16.2Gaps score details

Table 112 Gap score details – OSO 16

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

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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 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

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		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

Table 113 Gap score details – OSO 16

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 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	0	0

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				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 114 Gap score details – OSO 16

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.	-2	-6

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

Table 115 Gap score details – OSO 16

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

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

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
		Impact on EU Industry competitiveness (1)	No Impact	No difference expected from a standard on crew communication	0	0
		Social Acceptance (1)	No Impact	No difference expected from a standard on crew communication	0	0
Total Weighted Score						**-6**

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Table 116 Gap score details – OSO 16

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

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

Table 117 Gap score details – OSO 16

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

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		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 118 Gap score details – OSO 16

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

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

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

4.17.1 Identified gaps and recommendations

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Table 119 Identifed gaps and recommendations - 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.

4.17.2Gaps score details

Table 120 Gap score details – OSO 17

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

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

Table 121 Gap score details – OSO 17

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
		Safety (3)	Very High	Depending on the operation, resting might represent and important safety factor.	-2	-6

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2	Lack of standards to define a Fatigue Risk Management System (FRMS)	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**

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

4.18.1 Identified gaps and recommendations

Table 122 Identifed gaps and recommendations - OSO 18

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation

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1	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.	-2	It is recommended to develop standards covering automatic protection of the flight envelope following remote pilot errors specifically designed for small civil UAS.

4.18.2 Gaps score details

Table 123 Gap score details – OSO 18

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS.	Safety (3)	Low	The absence of standards is very sensitive for safety as these protections might not be correctly implemented resulting in vulnerability in case of remote pilot errors.	+1	+3
		Cost of compliance to the requirement with a lack standard (2)	Very High	Operational costs may increase as limitations on the remote pilot actions are set in order to comply with this requirement without a reference standard or following very demanding requirements.	-2	-4
		Environmental Impact (1)	No Impact	-	0	0

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		Impact on EU Industry competitiveness (1)	No impact	-	0	0
		Social Acceptance (1)	Negative	People may be concerned about the safety around UAS if they feel that UAVs are unpredictable in terms of flight stability.	-1	-1
Total Weighted Score						**-2**

4.19 OSO 19 – Safe Recovery from Human Error

4.19.1 Identified gaps and recommendations

Table 124 Identifed gaps and recommendations - 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.
2	Lack of standards addressing systems to detect and/or recover from human errors.	-4	It is recommended to develop best practices (for low robustness) and/or standards (for medium/high robustness) to address the

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			design of systems to detect and/or recover from human errors (Criterion #3).

4.19.2 Gaps score details

Table 125 Gap score details – OSO 19

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 and error recovery. For instance, visual observers are key elements for BVLOS operations. Their role is to support the RPIC in the flight management, especially to remark presence of other hazards (e.g. other traffic, obstacles etc) when the drone is not in the LOS of the remote pilot.[5]	-1	-3

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

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				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[6]. 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	-1	-1

[6] 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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				flights in urban environment. However there is a working draft ASTM WK62741 which will cover this gap in the future.		
Total Weighted Score						**-5**

Table 126 Gap score details – OSO 19

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards addressing systems to detect and/or recover from human errors.	Safety (3)	High	High tier operations of medium/high robustness (SAIL IV+) may require systems to detect and/or recover from human errors to be developed to industry recognised standards. The safe design of these systems is a crucial element to support UAS operations by reducing the likelihood and effects of human errors.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	Low tier operations may find compliance to a demanding design criterion too demanding. Conversely, higher tier operations would require compliance to the criterion, so the absence of such a standard/best practice would result too time consuming.	0	0
		Environmental Impact (1)	Not applicable		0	0

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		Impact on EU Industry competitiveness (1)	No impact	No impact on EU industry competitiveness identified.	0	0
		Social Acceptance (1)	Negative	The absence of (design) best practices ultimately aimed at avoiding human error may be seen negatively.	-1	-1
Total Weighted Score						**-4**

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

4.20.1 Identified gaps and recommendations

Table 127 Identifed gaps and recommendations - OSO 20

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	-4	The assessment shows that there is the urgency to develop standards to cover this gap. Work is on-going at EUROCAE level as WG 105/ SG 61 should publish in the future standards related to Applicability of Safe Design Standard for UAS in Specific Operations Category that will address, among the others, HMI design standards.
2	Lack of standards to conduct human factors evaluation of the	-5	The assessment shows that there is the urgency to develop standards to cover this gap.

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	UAS to determine if the HMI is appropriate for the mission.		The Human Performance Assessment (HPA) methodology developed in SESAR might be a good basis for the definition of such standards. Nevertheless, being HPA thought to cover manned aviation concepts, it may be difficult to deeply analyse some issues specific to drones using such methodology. Specific considerations on human factors for UAS are collected in the "Human Factors Guidelines for Unmanned Aircraft System Ground Control Stations" published by the NASA within the *UAS in the NAS* Project and might be considered when developing UAS-specific versions of human factors evaluation methodologies to cover the identified gap.

4.20.2 Gap score details

Table 128 Gap score details – OSO 20

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	Safety (3)	Medium	An adequate HMI is a crucial element to support UAS operations safety by reducing the likelihood and effects of human errors. In absence of a defined standard for UAS HMI design and development, it is hard for operators to understand to what extent the available HMI is able to safely support their missions in terms of information presentation, human error, fatigue.	0	0
		Cost of compliance to the requirement	Medium	In the presence of only information/guidance material, human factors considerations in the design and	-1	-2

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		with a lack standard (2)		development of the HMI (e.g. information presentation, human error, crew fatigue) may vary slightly from a manufacturer to another, with consequent costs for the operators to adapt their operation manuals to the different interfaces. On the other hand, it will be more time consuming for Authorities to verify adequacy of HMI design and development. The absence of a standard HMI development philosophies may also lead to increased training costs for pilots and crews.		
		Environmental Impact (1)	Neutral	An information/guidance doc to define adequate design and development guidelines for the HMI of drones, enables more efficient and safer operation compared to when such standard is completely absent, thus leading to environmental benefits.	0	0
		Impact on EU Industry competitiveness (1)	Negative	The available guidance, based on a military standard could potentially prove too restrictive for low and possibly medium robustness operations and could possibly hinder EU competitiveness.	-1	-1
		Social Acceptance (1)	Negative	Having a clear framework for the design and development of drones HMI (including automated safety features) would have a positive impact on public perception of drone operations safety.	-1	-1

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Total Weighted Score	-4

Table 129 Gap score details – OSO 20

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
2	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission.	Safety (3)	Low	An adequate HMI is a crucial element to support UAS operations safety by reducing the likelihood and effects of human errors. In absence of a defined standard for UAS HMI human factors evaluation, it is hard for operators to understand to what extent the available HMI is able to safely support their missions.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Medium	In absence of standards, it takes longer for operators to understand whether the HMI performance is adequate for the operations. On the other hand, it will be more time consuming for Authorities to verify adequacy of HMI human factors evaluation. The absence of a standard human factors evaluation of HMI may also lead to increased training costs for pilots and crews.	-1	-2
		Environmental Impact (1)	No impact	A standard to define adequate means of human factors evaluation for the HMI of drones would enable more efficient and safer operation, thus leading to environmental benefits.	0	0

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		Impact on EU Industry competitiveness (1)	Positive	The Human Performance Assessment Procedure has been developed in the SESAR framework, thus making it easier for EU based SMEs to adopt it (or a variant of it).	1	1
		Social Acceptance (1)	No impact	Having a clear framework for the evaluation and assessment of Human Factors issues of drones HMI (including automated safety features) would have a positive impact on public perception of drone operations safety.	-1	-1
Total Weighted Score						**-5**

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

4.21.1 Identified gaps and recommendations

Table 130 Identifed gaps and recommendations - 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

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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

4.21.2Gap score details

Table 131 Gap score details – OSO 23

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	There are no standards/guidelines to define how to determine adequate environmental conditions for safe operations.	Safety (3)	High	In case that drone safe environmental operating conditions are not properly defined there is a high risk of misuse of the equipment in non-safe conditions.	-1	-3
		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of compliance with defining safe conditions for operations should not be high since it is part of the testing and operators with a licence are already aware under what conditions they should fly a drone	+1	+2
		Environmental Impact (1)	Bad	Not properly defined safe operating conditions of drones could have adverse effect to the environment only in extreme	-2	-2

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				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 132 Gap score details – OSO 23

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

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		Cost of compliance to the requirement with a lack standard (2)	Low	The cost of a third party to check whether the training syllabus or the UAS operator is competent in safe environmental conditions is carried out at a local level anyway	+1	+2
		Environmental Impact (1)	Neutral	No environmental impact	0	0
		Impact on EU Industry competitiveness (1)	No impact	No impact	0	0
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**+2**

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

4.22.1 Identified gaps and recommendations

No gaps were identified in OSO #24 for medium Integrity / robustness as the identified standards seem to cover adequately all the requirements. No existing or upcoming standard assessed by the consortium has been identified to fully cover "high" integrity / robustness criteria of OSO #24.

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4.23 Adjacent Area/Airspace Considerations

4.23.1 Identified gaps and recommendations

Table 133 Identifed gaps and recommendations – Adjacent Area

Gap #	Gap Description	Total Weighted Score	Conclusion Recommendation
1	There is a lack of standards for SW and airborne electronic hardware (AEH) Development Assurance that are suitable for small UAS	-9	It is recommended to develop a standard for SW and AEH development assurance that is suitable for small UAS. EUROCAE WG-117 activity on this topic is expected to cover this gap for the part related to software.

4.23.2 Gaps score details

Table 134 Gap score details – Adjacent area

Gap	Gap Description	Criterion (Weight)	Result	Rationale	Score	Weighted Score
1	There is a lack of standards for SW and airborne electronic hardware (AEH) Development Assurance that are suitable for small UAS	Safety (3)	High	A lack of standards does not guarantee a way to assess whether the current means adopted by drone manufacturers to comply with the requirement is reliable.	-1	-3

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		Cost of compliance to the requirement with a lack standard (2)	Very High	Complying to requirements born to suit only larger aircrafts is time consuming and expensive.	-2	-4
		Environmental Impact (1)	Neutral	No impact	0	0
		Impact on EU Industry competitiveness (1)	Very Negative	A very high cost of compliance will reflect analogously on EU industries.	-2	-2
		Social Acceptance (1)	No impact	No impact	0	0
Total Weighted Score						**-9**

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5 Summary of identified gaps (SORA)

The following tables provide per SORA requirement (mitigation or objective) a summary of the identified gaps , i.e. the aspects from criteria that are not adequately covered by the, their classification and their weighted score.

Table 135 Strategic Mitigations for Ground Risk: Gap summary

Mitigation	Gap description	Classification	Weighted score
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

Mitigation	Gap description	Classification	Weighted score
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 136 Tactical Mitigations Performance Requirements: Gap summary

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

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Tactical Mitigations - BVLOS	Lack of standards (i.e. MOPS) for small drones above VLL.	Technical	-9

Table 137 OSO: Gap summary

Objective	Gap decription	Classification	Total weighted score
OSO 01	There is no guideline or standard defining the minimum requirements for organizations in terms of structure, post-holders, etc. for categories of operations.	Procedures	-4
OSO 02	Absence of standards addressing specifically UAS manufacturing processes and quality assurance, that are applicable for any UAS.	Technical	+2
OSO 03	N/A		
OSO 04	N/A		
OSO 05	N/A		
OSO 06	All identified technical standards cover Command and Control, but there is no standard to develop communication functionalities where needed/relevant.	Technical	-4
OSO 07	Absence of standards covering: Product inspection is documented and accounts for the manufacturer's recommendations if available	Procedures	10
	Absence of standards covering: A competent third party validates the training syllabus and verifies the remote crew competencies.	Procedures	-1
OSO 08, 11, 14, 21	N/A		
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	Standards covering automatic protection of the flight envelope following remote pilot errors are not designed specifically for small UAS..	Technical	-2
OSO 19	Lack of standards covering training requirements for personnel, other than remote pilot, in charge of duties essential to the management of the flight	Training	-5
	Lack of standards addressing systems to detect and/or recover from human errors.	Technical	-4
OSO 20	Lack of specific standards to define platform-independent Human Machine Interface (HMI) capabilities.	Technical	-4
	Lack of standards to conduct human factors evaluation of the UAS to determine if the HMI is appropriate for the mission.	Procedures	-5
OSO 23	There are no standards/guidelines to define how to determine adequate environmental/ meteorological conditions for safe operations.	Procedures	-5

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	No current standard completely covers third-party competence for checking environmental/meteorological conditions for both syllabus and skills.	Procedures	+2
OSO 24	N/A		

Table 138 Adjacent Area/Airspace Considerations: Gap summary

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

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6 U-Space services coverage, gaps and recommendations

This section provides for each of the identified U-Space services the identified standards which are deemed suitable to support verification of conformity of the U-Space service. For each U-Space service the following information is provided:

- The list of standards which offer at least a partial coverage, including a description of any limitations.
- A score per standard. In Annex V of D4.3 AW-Drones proposed standards – 3rd iteration (U-Space 1) the reader will find the rationale behind the score assigned to each standard.
- The gaps (i.e. the aspects from the U-Space services that are not adequately covered by the standards) are provided.
- Recommendations on how to fill the identified gaps.

6.1 Network identification service ①

6.1.1 Requirement coverage & gaps

Requirement	Coverage	Recommended standard(s)	Score	Limitations/notes	Gaps
1. A NIS shall allow the continuous processing of the remote identification of the UAS	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10	The ASTM F3411 standard describes NIS in detail, but as the required received messages do not comply with the EU legislation it does not fit NIS requirements completely (see requirement 2)	A European NIS standard is required in order to cover for the full NIS description on not only what to exchange , but also how to exchange, define a minimum security to protect the data, define which data to provide to which users.
		EUROCAE ED-282, MOPS for UAS E-Identification	-3	The EUROCAE standard details which messages to transmit, but does not detail the	

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				format in order to exchange messages between multiple USSP's	
2. The NIS shall allow for the authorised users to receive messages with the following content:	Partial coverage	None		ASD STAN prEN4709-002 covers the requirements but only for DRI, not NIS ASTM F3411 only partly covers the messages to receive (see gap analysis)	Absence of a standard coverage for NIS to receive following mandatory messages : - UAS operator registration number -the emergency status of the UAS - the geographical position of the remote pilot or, if not available, the take-off point As these requirements are specific to the European union, it is recommended to establish a European NIS standard.
2.a) the UAS **operator registration number**;	N/A	/			This requirement is not covered by any identified standard.
2.b) the unique **serial number** of the unmanned aircraft **or**, if the unmanned	Full coverage	ASTM F3411-19, UAS Remote ID and Tracking	10	This requirement is covered by ASTM F3411	

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aircraft is privately built, of **the add-on**;					
2.c) *the geographical* ***position*** *of the UAS, its* ***altitude above mean sea level*** *and its* ***height above the surface or take-off point***	Full coverage	ASTM F3411-19, UAS Remote ID and Tracking	10	This requirement is covered by ASTM F3411	
2.d) the **route course** measured clockwise **from true north** and the **ground speed** of the UAS;	Full coverage	ASTM F3411-19, UAS Remote ID and Tracking	10	This requirement is covered by ASTM F3411	
2.e) the geographical **position of the remote pilot or**, if not available, the **take-off point**;	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10	Is an optional field in ASTM F3411	Is not a mandatory field in ASTM F3411
2.f) the **emergency status** of the UAS;	N/A	/			This requirement is not covered by any identified standard.
2.g) the **time** at which the **messages**	Full coverage	ASTM F3411-19, UAS Remote ID and Tracking	10		

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were **generated**					
3. The **information** provided by the NIS shall be **updated** at a **frequency** that the competent **authority has determined**.					
4.The authorised users shall be:		ASTM F3411-19, UAS Remote ID and Tracking	10	• The ASTM F3411 standard describes NIS in detail, but as the required received messages do not comply with the NIS requirements in the EU legislation. • Further screening and assessment of communication requirements will be handled in 9.3.	A European NIS standard is required in order to cover for the full NIS description on not only what data messages to exchange, but also how to exchange, define a minimum security to protect the data, define which data to provide to which users.
4.a) the **general public**	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10		Not all the required content in communication to the general public (stated in requirement 2a-2f) is addressed, having a negative

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					impact on EU Industry competitiveness
4.b) **other USSPs**	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10		Not all the required content in communication to the other USSPs (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
4.c) the **ATS providers** concerned;	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10		Not all the required content in communication to the ATS providers (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness
4.d) when designated, **the CISP**					
*4.e) the relevant **competent authorities***	Partial coverage	ASTM F3411-19, UAS Remote ID and Tracking	10		Not all the required content in communication to the competent authorities (stated in requirement 2a-2f) is addressed, having a negative impact on EU Industry competitiveness

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Exchange of drone tracking information over NIS on any drone traffic in the Designated Operational Coverage (DOC)[5].	Not covered	/		No European standards are currently identified	The EU Commission Regulation (EU) 2020/1058 covers the requirements for the airborne function supporting Network Remote Identification, however standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO, on 10 October 2021, approved development of 23629-9 (UTM Part 9) on the interface between UTM service providers and users.
Display of the drone tracking information in the DOC	Not covered			No European standards are currently identified	Standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and

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					EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (see above row).
Exchange of drone tracking information between multiple USSPs, which cover different DOCs	Not covered			No European standards are currently identified	Standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspective. To cover these communication interfaces, ISO is initiating development of 23629-9 (see first row in this table).

Table 139, **Requirements covergave and gaps – Network Information Service**

a) NIS presupposes that identity and position are transmitted by the unmanned aircraft in flight;
b) But also manned aircraft may be electronic conspicuous, based on Commission Regulation 2021/666. On 31/08/2021 a workshop organized by EASA presented the results of a study to evaluate if mobile technology can be used to make unmanned aircraft electronically conspicuous in U-space. EASA proposed to organize a follow up on the questions and finalize the study.
c) DG MOVE and EASA should avoid proliferation of standards, meaning that that the same standard should be used for 'electronic identification' of unmanned aircraft and for 'e-conspicuity' of manned aircraft flying in the same volume of airspace;
d) DG GROW should withdraw the mandate to CEN (ASD-STAN) for EN 4709-002, again to avoid proliferation of standards;

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e) The EUSCG should promote harmonisation of ASTM F3411-19 and EUROCAE ED-282 under the global umbrella of ISO 23629-8;

f) EU members of ISO TC 20 SC 16 should promote insertion of technologies for Communication in ISO 23629-9;

g) EASA should publish an AMC to 2021/664, similar to AMC1 to rule ARO.GEN.305(b);(c);(d);(d1) on the oversight programme related to Regulation 965/2012, so clarifying that for the UTM Communication Service (UCS) Provider, industry certification based on ISO 23629-12 would suffice.

6.1.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering: the limitation to direct remote identification leaves air traffic control and authorities without a situational awareness of drones flying around in their area of responsibility	The lack of a standardisation of UTM communication services and to compose an overall drone traffic information platform for authorities might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives. ISO 23629-12 is promising and satisfactory for the safety and quality of the related service providers, but additional technical standards (e.g. EUROCAE ED-282 or ISO 23629-8) may be necessary. *Latest draft U-Space regulation introduces in Article 8 the notion of Network Identification Service.* *ASTM F38 committee has published in 2019 F3411-19 "Standard Specification for Remote ID and Tracking" and it is highly expected that EASA will recognise this standard as AMC to the future U-Space regulation Article 8.* *Still, two areas are currently not completely covered by ASTM F3411-19 standard:* ***Identification Framework*** *A mapping of the needs shall be performed:* *Do we need a registration ID beyond what is currently requested per (EU) 2020/639 Article 14? If yes, for which part (the aircraft, the pilot, the operator,...) and what are the legal implications?*

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		At a given time, how will each flying object be identified in an unambiguous manner? ***Authentication*** *The identity of each flying object shall be trusted. A standard needs to cover this part. This part of the standard will need to consider on-going work from ICAO Global Aviation Trust Framework. With the high level objective of tackling U-Space/UTM future security challenges, the ICAO TF is working on concept of unique ID for all U-Space/UTM users and authentication issues.* *These two areas are proposed to be addressed by Eurocae WG-105."*

Table 140, Gap description and recommendations – Network information service

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6.2 Geo-awareness service ②

6.2.1 Requirement coverage & gaps

Requirement	Coverage	Recommended standard(s)	Score	Limitations/notes	Gaps
1. A GAS consisting of the following geo-awareness information shall be provided to UAS operators:					
1.a) Information on the applicable **operational conditions** and **airspace constraints** within the designated **U-space airspace**;	Partial coverage	EUROCAE ED-269, Minimum Operational Performance Standard for Geo-Fencing	4	Conditions are available as logical expression for each UAS geographical zone. It's assumed that the standard can be used for the conditions on a U-Space airspace as for a UAS geographical zones	The standard is mostly used for UAS geographical zone, the requirement focuses the conditions within a designated U-space airspace.
1.b) **UAS geographical zones**, relevant to the designated U-space airspace	Partial coverage	EUROCAE ED-269, Minimum Operational Performance Standard for Geo-Fencing	4	The standard can be used to exchange UAS geographical zones. The standard only contains uspace type and doesn't contain a reference of a specific U-space instance	A reference to a designated U-space airspace could have covered the requirement fully
1.c) **temporary restrictions** applicable to	Full coverage	EUROCAE ED-269, Minimum Operational	4	The standard is capable storing time validity period	Need for some more fexible time

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airspace use **within** the **U-space airspace**		Performance Standard for Geo-Fencing		for a UAS geographical zone	annotations (see above)
2. U-space service providers shall dispatch the geo-awareness information in a timely manner to allow **contingencies and emergencies** to be addressed by UAS operators, and shall **include its time of update** together with a **version number or a valid time, or both**.	Partial coverage	EUROCAE ED-269, Minimum Operational Performance Standard for Geo-Fencing	4	The standard can describe a version for a UAS zone and assign a time period to it. Requirement of the standard: The Geoawareness function shall provide the remote pilot with a clear indication of the time since the last successful update of the UAS geographical zones data. It is the responsibility of the remote pilot to ensure the update is made appropriately before and during flight, as defined by the applicable regulation	Dispatching geo-awareness information: standard It is the responsibility of the remote pilot to ensure the update is made appropriately before and during flight, as defined by the applicable regulation. The standard doesn't cover the dispatching requirement.
Information on the applicable operational conditions and airspace constraints within the designated U-space airspace;	partial	EUROCAE ED-269, Minimum Operational Performance Standard for Geo-Fencing	4	Conditions are available as logical expression for each UAS geographical zone.	More general data model applicable beyond GAW
Dynamic airspace restrictions temporarily limiting the area	partial	EUROCAE ED-269, Minimum Operational Performance	4	The standard is capable storing	

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within the designated U-space airspace where UAS operations can take place.		Standard for Geo-Fencing		time validity period for a UAS geozone	
U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, and shall include its time of update together with a version number or a valid time, or both.	partial	EUROCAE ED-269, Minimum Operational Performance Standard for Geo-Fencing	4	The standard can describe a version for a UAS zone and assign a time period to it.	
U-space service providers shall: (a) exchange any information that is relevant for the safe provision of U-space services amongst themselves; (b) adhere to an appropriate open communication protocol …	partial	ISO 23629-7, UAS Traffic Management (UTM) – Part 7: UTM data and information transfer at interface of traffic management integration system and UAS service providers - Data model related to spatial data for UAS and UTM	7	Generic data model to exchange all types of data in UTM. Scope covering all exchanges relevant in the U-space, but not sufficiently detailed.	It is complementary to more detailed ED-269

Table 141, Requirements covergave and gaps – Geo-awareness service

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6.2.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	No standard has been developed specifically for this purpose. Though no major gaps are identified using the complementary standards ED-269 and ISO 23639-7	The ED-269 data model has been put forward to describe the geo-zones though is lacking some nomenclature/features which should be added in a next iteration of the standard. Not clear which 'restriction type' will be used to describe a U-space geo-zone.

Table 142, Gap description and recommendations – Geo-awareness service

In summary it is recommended to:

a) Propose ED-269 as GM to Regulation 2021/664;
b) Through EUSCG encourage development of a second edition of ISO 23629-7, mentioning in it EUROCAE ED-269 for more detailed specifications.

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6.3 UAS flight authorisation service ③

6.3.1 Requirement coverage & gaps

The Flight Authorisation Service (alias FCS) as currently defined in the U-space regulation 2021/664 implies interaction among a variety of individual services (e.g. strategic deconfliction, priority management, dynamic, authorisation management) and actions needed which are grouped together. This means that in the future several standards will apply fully or partially to this services but also that currently there is no standard mature enough to support the interfaces necessary for this service. The standards or drafts assessed for this service were either in a premature phase (or were applicable to this service but only covered a small, though important aspect. This is the case for standard ISO 23629-7.

It is not foreseeable that a single standard would cover completely the 'flight authorization service'. ISO 23629-9, is developing a standards covering necessary interfaces but is still being drafted.

Requirement	Coverage	Recommended standard	Score	Limitations/notes	Gaps
1. The **USSPs shall provide** UAS operators with the UAS **flight authorisation** for each individual flight, setting the **T&C** of that flight, through a **UAS flight authorisation service**					No gap
2. Upon receiving an UAS flight authorisation request USSP shall: (a) check if request is complete and correct	not covered	N/A		.	Data exchanges between UAS operator and USSP, including response from USSP to a flight authorisation request, possibly covered by ISO 23629-9, whose development

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(b) accept the request if the intended flight is free of intersection in space and time with any other notified flight (c) notify UAS operator about acceptance or rejection (d) when accepting, indicate allowed flight authorisation deviation thresholds.					was however approved only on 10 October 2021 (i.e. still in the planning stage).
3. When issuing a flight authorisation, the USSP shall use, where applicable, weather information provided by WIS	Covered	ISO 23629-7, Data model for spatial data	9	This standard covers the geospatial data, including “phenomena” and associated geographical position and time	No gaps
4. USSPs may propose an alternative UAS flight authorisation to the UAS operator.	Covered	ISO 23629-7, Data model for spatial data	9	This standard covers the geospatial data, including description of the intended route.	No gaps
5. Upon receiving the request, the USSP shall confirm the activation of the UAS flight authorisation	Not covered	None		Maximum permissible times related to transaction, might be included in ISO 23629-9	Maximum permissible times for data exchanges between UAS operator and USSP, including

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without unjustified delay					response from USSP to a flight authorisation request, possibly covered by ISO 23629-9, which is however only in the planning stage.
6. USSPs shall establish proper arrangements to resolve conflicting UAS flight authorisation requests received from UAS operators by different USSPs.	Not covered	ASTM - WK63418, New Specification for Service provided under UAS Traffic Management (UTM) Or ISO 23629-9, Interface between UTM service providers and users	2 -2	Both standards are in the planning stage.	Not even a preliminary draft of either candidate standard is available. ISO 23629-9 should be preferable, since oriented to the global market and not to a single country.
7. USSP shall check the request for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations.	Covered	ISO 23629-7, Data model for spatial data	9	This standard covers the geospatial data, including attributes of the geo-limitations.	No gaps.
8. When processing UAS flight authorisation requests, the USSPs shall give priority to UAS	Covered	ISO 23629-12, UAS traffic management (UTM) — Part 12: Requirements for UTM		This standard covers the organisation of the service providers and does not	No gaps

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conducting special operations as referred to in Article 4 of Implementing Regulation (EU) No 923/2012		services and service providers		require detailed technical standards. ISO 23629-12 covers safety and quality of all USSPs, including a monitoring functions to verify compliance of procedures with applicable regulations.	
9. When two UAS flight authorisations requests have the same priority, they shall be processed on a first come first served basis					
10. USSP shall continuously check existing flight authorisations against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic shared by relevant ATS units, and update or withdraw authorisations as may be necessitated by the circumstances.	Partial	ISO 23629-7, Data model for spatial data	9	ISO 23629-7 contains a “dynamic data package”, but however limited to aircraft and whether phenomena	The “dynamic data package” in ISO 23629-7 should be amended, to include also dynamic airspace restrictions and limitations.

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11. USSP shall issue a unique authorisation number for each UAS flight authorisation.	Partial	ISO 23629-7, Data model for spatial data	9	ISO 23629-7 contains a UAS "Object", including the flight identifier. However, how to encode this identifier is not specified therein.	The "UAS object" in ISO 23629-7 should be amended, to include standards to encode the flight identifier. Alternatively, this should be covered by ISO 23629-9

Table 143, Requirements covergave and gaps – UAS flight authorisation service

6.3.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the interface among several FCS Providers	ASTM F38 is developing a UTM interoperability standard for a set of services such as strategic conflict detection (to support strategic deconfliction), conformance monitoring and geo-awareness (constraint management). Though this standard is not directly applicable to the U-space FAS service. Latest draft U-Space regulation introduces in Article 10 the notion of Flight Authorisation Service with the intent to setting the terms and conditions of UAS flights within U-Space. EUROCAE WG-105 SG3 intends to work with EASA expert group on U-Space AMC/GM – Sub-group 5 to identify the need of new standard(s) in support of the future Flight Authorisation service.

Table 144, Gap description and recommendations – UAS flight authorisation service

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6.4 Traffic information service ④

6.4.1 Requirement coverage & gaps

The standards used for General Aviation must be further investigated. A potential problem is that U-space will use different device requirements, based on Regulation 2021/666.

Requirement	Coverage	Recommended standard	Score	Limitations/notes	Gaps
1. TIS provided to the UAS operator shall contain information on any other conspicuous air traffic, that may be in proximity to the position or intended route of the UAS flight.	Partial	ISO 23629-7, Data model for spatial data and ISO 23629-12, UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	9 3	These standards cover the definition of the “flight object” (whether manned or unmanned), and the safety and quality of the TIS provider. However, they do not cover the communication means to exchange the TIS information between the USSP and the UAS operator	Interface requirements are planned to be covered through ISO 23629-9
2. TIS shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	/	/		No standards are currently identified	No requirements are currently covered by a potential AMC

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3. TIS shall provide information about other known air traffic and shall: (a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known; (b) be updated at a frequency that the competent authority has determined.	Covered	ISO DIS 23629-7, Data model for spatial data	9	This standard contains definition of flight "objects", whether the aircraft is manned or not.	No gaps
4. Upon receiving the traffic information services from the U-space service provider, UAS operators shall take the relevant action to avoid any collision hazard.					

Table 145, Requirements covergave and gaps – Traffic information service

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6.4.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	Absence of standard covering the technical details for transmission of TIS information on a frequency different from 1030/1090 MHz or for exchange if data between USSP and UAS Command Unit (CU).: information on any other conspicuous air traffic, which may be in proximity to the position or intended route of the UAS flight.	Flight objects, necessary to exchange TIS information, are covered by ISO 23629-7. However, lack of a standardisation of communication means might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
2	Information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units.	The lack of a standardisation of communication and to exchange information on TIS across several providers might compromise uniform safety. Standardisation would be beneficial for uniform safety and EU industry perspectives.
3	Information about the position of other known air traffic	Content of the traffic information has been defined, standardisation of the communication protocol is missing, development of such protocol would be beneficial for uniform safety and EU industry perspectives. The case that the TIS information is provided to the CU and not directly to the unmanned aircraft should be considered.

Table 146, Gap description and recommendations – Traffic information service

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6.5 Weather information service ⑤

6.5.1 Requirement coverage & gaps

Requirement	Coverage	Recommended standard	Score	Limitations/notes	Gaps
1. Provision of weather data before and during the flight	Partial	ISO CD 23629-7, Data model for spatial data	9	• Contains data models for meteorological phenomena. • Partially compliant with draft U-space regulations, because only defining which information should be exchanged, but not interfaces	236297 should be complemented by 235629-9 specifying the interfaces to exchange the information, as necessary also for weather related data
2. Content and format of weather data messages	Covered	ISO CD 23629-7, Data model for spatial data	9	Contains data models for meteorological phenomena.	No gaps identified
3. Safety and quality of weather information	Covered	ISO CD 23629-12, UAS traffic management (UTM) — Part 12: Requirements for UTM services and service providers	5	Contains safety and quality requirements for all USSPs, including WIS	No gaps identified

Table 147, Requirements covergave and gaps – Weather information service

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6.5.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	Provision of weather data before and during the flight	Further standards on interfaces between USSPs and UAS Operators should be developed. One possibility is ISO 23629-9, being progressed by WG4 of ISO TC/20 SC/16
2	Content and format of weather data messages	No gaps identified, once ASTM WK73142 will be issued
3	Safety and quality of weather information	No gaps identified at the level of consensus-based standards, since ISO 23629-12 covers this topic. However, a general AMC published by EASA and specifying under which conditions consensus-based industry standards may constitute presumption of compliance with the rules, is highly desirable. AMC to AIR-OPS already contain a similar AMC, which, for ease of reference is reproduced in Annex IV.

Table 148, Gap description and recommendations – Weather information service

More research on how to convert from geodetic height to barometric altitude, for both manned and unmanned aviation is underway through the EU funded project ICARUS[7].

ICARUS has proposed three additional U-space services for this purpose, covering also vertical separation from obstacles. These three services are listed in ISO DIS 23629-12.

The Commission should consider limiting the requirement for certification by the authority only to safety-critical services.

For such services, certification based on ISO 23629-12 may be credited, as it already happens in Regulation 965/2012.

[7] https://www.u-spaceicarus.eu/

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For service other than safety-critical, voluntary certification based on ISO 23629-12 could be sufficient, for UAS operators to discharge their responsibility related to SORA OSO #13.

The EUSCG could recommend to:

a) ASTM not to include requirements on the organisation of the WIS provider in their WK73142; and

ISO to mention the ASTM standard in a note in 23629-12, since the former would contain more technical details on the WIS service.

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6.6 Conformance monitoring service ⑥

6.6.1 Requirement coverage & gaps

Requirement	Coverage	Recommended standard	Score	Limitations/notes	Gaps
1. alert the UAS operator when the flight authorisation deviation thresholds are violated	Partial	ASTM WK63418, New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability		Applicability limited to some guidance in latency	
2. alert the other UAS operators operating in the vicinity of the UAS operators violating the deviation thresholds	Partial	ASTM WK63418, New Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability		Applicability limited to some guidance in latency	

Table 149, Requirements covergave and gaps – Conformance monitoring service

6.6.2 Gap description and recommendations

Gap #	Gap Description	Conclusion Recommendation
1	Identified standards lack full coverage and design and implementation details.	It is recommended to detail the design and implementation. The lack of the latter might affect the efficiency of UAS operations.

Table 150, Gap description and recommendations – Conformance monitoring service

There is still a need for cyber-security standards for connections between CISP and USSP with reference to CMS (and other services).

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7 SC-Light UAS

This section provides for each requirement of the SC-Light UAS the standards that are recommended as a preferred MoC for SAIL III and IV of the related OSO(s), and the gaps.

For each requirement of the SC-Light UAS the following information is provided:

- The link of the requirement with the SORA Operational Safety Objective(s).
- The standards that are recommended as a preferred MoC for SAIL III and IV of these OSO(s).
- Gaps in the coverage of the requirement by these standards for SAIL III and IV of these OSO(s).

7.1 Subpart B – Flight

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III and IV	Gaps for SAIL III and IV
Light-UAS.2100	#4	ASTM F3298 – 19 Sections 5, 7, 9, 13, 14 and 16	None
Light-UAS.2102	#4	None	There is a gap
Light-UAS.2105 a), c), d)		None	There is a gap: ASTM F3298 – 19 should be complemented with additional guidance to support the demonstration of compliance for sub-requirements a), c), d).
Light-UAS.2105 b)	#4	ASTM F2908 – 18 Section 7.6	
Light-UAS.2135	#4	ASTM F3298 – 19 Sections 5, 16	No gap, but cost of compliance may be high for SAIL III and IV as verification is required through demonstration at all points of the flight envelope.
Light-UAS.2160	#4	ASTM F3298 – 19 Sections 7, 16	None

Table 151, Requirements covergave and gaps – Subpart B - Flight

Subpart B requirements 2100, 2135 and 2160 have a full coverage by ASTM F3298 – 19 Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems.

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For the requirement Light-UAS.2102, ASTM F3298 − 19 would need to be used in conjunction with other standards to support the demonstration of compliance. IEC 60529 – "Degrees of protection provided by enclosures (IP Code)" is widely used by several UAS manufacturers and there are already products on the market which are compliant to its specifications, but this is a general product standard, not specific for UAS. Nonetheless, it does not cover sub requirement a).

For the requirement Light-UAS.2105, only only partially addresses the special condition and would need to be used in conjunction with other standards (e.g. ASTM F2908 – 18 Standard Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)).

7.2 Subpart C – Structures

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III and IV	Gaps for SAIL III and IV
Light-UAS.2235	#4	ASTM F3298 – 19 Sections 7 and 9	None
Light-UAS.2240	#4	ASTM F3298 – 19 Sections 8 and 16 + ASTM F2909-19 + ASTM F3366-19	None
Light-UAS.2250 a), b)	#4	ASTM F3298 – 19 Sections 8, 14	There is a gap for subrequirement c)
Light-UAS.2250 c)	#4	None	
Light-UAS.2260	#4	ASTM F3298-19 Section 7.3, 16.2	None

Table 152, Requirements covergave and gaps – Subpart C - Structures

ASTM F3298 is a good candidate MoC for most the requirements in Subpart C for SAIL III and IV. For requirement 2240 the full coverage for SAIL III and IV is reached with the combination of with ASTM F3298, F2909 and F3366

A gap has been identified for *Light-UAS.2250 Design and construction principles.*

ISO CD 21384-2 is a good candidate and is potentially covering the identified gap for *Light-UAS.2250.*

In addition to the mentioned standards, "ASTM F3478-20 Standard Practice for Development of a Durability and Reliability Flight Demonstration Program for Low-Risk Unmanned Aircraft Systems (UAS) under FAA Oversight" for compliance by flight tests should be considered as useful for all the subparts, where flight tests are considered as adequate mean of verification.

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7.3 Subpart D - Design and Construction

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III and IV	Gaps for SAIL III and IV
Light-UAS.2300	#4	ASTM F3298 – 19 Sections 10, 16 + ASTM F3002-14a + ASTM F3003	None
Light-UAS.2305	#4	ASTM F3298 – 19 Sections 7.10, 16	None
Light-UAS.2325	#4	ASTM F3298 – 19 Sections 7, 16	There is a gap: test on battery-induced fires are not included
Light-UAS.2335	#24	Several standards available but actual applicability must be further assessed after a technical evaluation.	
Light-UAS.2340	#4	ASTM F3298 – 19 Sections 7 and 16 + ASTM F2909-19 + ASTM F3366-19	None
Light-UAS.2350 a)	#5	None	There is a gap
Light-UAS.2350 b)	#5	ASTM F2908-18 Section 7	There is a gap: standard only includes specifications for the landing area required at a normal recovery site using normal landing/recovery procedure
Light-UAS.2370 a), b)	#4	ASTM F3298 – 19	None
Light-UAS.2370 c)	#4	ASTM F3366 – 19	None
Light-UAS.2375	#5	ASTM F3298 – 19 Section 12, 16	None
Light-UAS.2380 (a), (c)	#4 #13	ASTM F3298 – 19 Section 11	None
Light-UAS.2380 (b)	#4 #13	ASTM F2908 – 18 Section 7	None

Table 153, Requirements covergave and gaps – Subpart D – Design and Construction

7.4 Subpart E - Lift/thrust/power system installation

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III	Gaps for SAIL III	Recommended standards for SAIL IV	Gaps for SAIL IV

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Light-UAS.2400	#4	ASTM F3298 – 19 Section 7.9	Point (f) not addressed	ASTM F3298 – 19 Section 7.9	Point (f) not addressed
Light-UAS.2400(c)	#5	ED-280 and ED-279 complemented with a Common Mode Analysis following ASTM F3309 § 4.6. Design and installation appraisal from ASTM F3309 §4.4.1 and 4.4.2	None	Same as SAIL III	
Light-UAS.2405	#4	ASTM F3298 – 19 Sections 16.3 and 16.4	Only general guidance provided. Further technical assessment needed	Same as SAIL III	
Light-UAS.2410	#4	ASTM F3298-19 Section 15, 16.3 and 15.4 F3478-20	F3478-20 not fully assessed	Same as SAIL III	
Light-UAS.2415	#4	ASTM F3298-19 Section 15, 16.3 and 15.4	None	Same as SAIL III	
Light-UAS.2430(a)	#4 and #5	ASTM F3298-19 Sections 10.5.7.2 and 10.5.7.3	None	Same as SAIL III	
Light-UAS.2430(b)	#4	ASTM F3298-19 Section 7.9.5 ISO 21384-2 section 9 ASTM F3005 or IEC 62133:2017 for batteries	None	Same as SAIL III	

Table 154, Requirements covergave and gaps – Subpart E - Lift/thrust/power system installation

From the table above the following gaps are identified in relation to MoC that are not considered adequate to fulfil the requirements:

- Light-UAS.2400: there is no standard explicitly addressing point (f) "All necessary instructions, information and limitations for the safe and correct interface between the lift/thrust/power

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system and the UA need to be available". Existing standards on Flight Manuals and maintenance Manual are assessed as too generic.

- Light-UAS.2405: existing standard only provides general guidance provided. Further technical assessment is needed to better evaluate the adequacy of the standard to be used as a MoC.

7.5 Subpart F - Systems and Equipment

<table>
<tr><th>SC Requirements</th><th>Link SORA OSO(s)</th><th>Recommended standards for SAIL III</th><th>Gaps for SAIL III</th><th>Recommended standards for SAIL IV</th><th>Gaps for SAIL IV</th></tr>
<tr><td rowspan="3">Light-UAS.2510</td><td>#5</td><td>ED-280 and ED-279 complemented with a Common Mode Analysis following ASTM F3309 § 4.6. Design and installation appraisal from ASTM F3309 §4.4.1 and 4.4.2</td><td>None</td><td>Same as SAIL III</td><td>Point (a)(3) not covered</td></tr>
<tr><td>#10,12 (SW)</td><td>ASTM F3201 – 16</td><td>None</td><td>EUROCAE ED-12C and EASA AMC 20-152A</td><td>None</td></tr>
<tr><td>#10,12 (HW)</td><td>EUROCAE ED-80 and EASA AMC 20-115D</td><td>None</td><td colspan="2">Same as SAIL III</td></tr>
<tr><td>Light-UAS.2511(a) and (b)(2)</td><td rowspan="3">Step #9</td><td>ED-280 and ED-279 complemented with a Common Mode Analysis following ASTM F3309 § 4.6. Design and installation appraisal from ASTM F3309 §4.4.1 and 4.4.2</td><td>None</td><td colspan="2">N.A.</td></tr>
<tr><td>Light-UAS.2511(b)(1)</td><td>EUROCAE ED-269 and ED-270 depending on the required probability</td><td>None</td><td colspan="2">N.A.</td></tr>
<tr><td>Light-UAS.2511(b)(3)</td><td>For SW: ASTM F3201 – 16 or</td><td>None</td><td colspan="2">N.A.</td></tr>
</table>

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		EUROCAE ED-12C and EASA AMC 20-152A depending on containment reliability For HW: EUROCAE ED-80 and EASA AMC 20-115D		
Light-UAS.2512	M1 and M2	Recommended standards depending on selected mitigation. See deliverable D4.3		
Light-UAS.2515	#24	Several standards available but actual applicability must be further assessed after a technical evaluation. For details see deliverable D4.3		
Light-UAS.2520	#24	ASTM F3367-21	Standard to be further assessed as it is not currently accepted by EASA for manned aircraft. No coverage for GCS	Same as SAIL III
Light-UAS.2528	#18	EUROCAE Guidelines on the Automatic protection of the flight envelope from human errors for UAS	Standard still under development	Same as SAIL III
Light-UAS.2529	#4	ASTM F3298 – 19 (10.2.2), ISO CD 21384-2 (10.5) and EUROCAE guidelines for the use of multi-GNSS solutions for UAS	No gap but EUROCAE guidelines not published yet	Same as SAIL III
Light-UAS.2530	#4	ASTM F3298 – 19 (A2.4.2 and A2.4.3)	Strobe lights not covered	Same as SAIL III
Light-UAS.2575	#5	ASTM F3002-14	It only addresses UAS < 25kg Communication function is not covered	Same as SAIL III

Table 155, Requirements covergave and gaps – Subpart F – Systems and Equipment

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7.6 Subpart G - Remote Crew Interface and Other Information

SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III	Gaps for SAIL III	Recommended standards for SAIL IV	Gaps for SAIL IV
Light-UAS.2600	#4	F3002-14a: Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	Only covers integration of C2 Link. For verification methods refer to ASMT F3003	Same as SAIL III	
Light-UAS.2602	#20	No standard recommended			
Light-UAS.2605-2610-2615	#4 #20	F3298-19: Standard Specification for Design, Construction and Verification for Lightweight Unmanned Aircraft Systems (UAS)	Applicability for UAS with MTOM > 25kg to be assessed	Same as SAIL III	
Light-UAS.2620	N.A.	F2908-18 Standard Specification for Aircraft Flight Manual (AFM) for a Small Unmanned Aircraft System (sUAS)	None	Same as SAIL III	
Light-UAS.2625	N.A.	F2909-19 Standard Practice for Maintenance and Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS) Complemented by F3366-19 Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)	None	Same as SAIL III	

7.7 Subpart H - C2 Link

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SC Requirements	Link SORA OSO(s)	Recommended standards for SAIL III	Gaps for SAIL III	Recommended standards for SAIL IV	Gaps for SAIL IV
Light-UAS.2710	#6	No standard recommended			
Light-UAS.2715		ED-266 - Guidance on Spectrum Access, Use and Management for UAS complemented by a technology-specific standard (see list in deliverable D4.3)	no Gaps	Same as SAIL III	
Light-UAS.2720		F3002-14 - Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)	It does not cover the reporting of the information in the Flight Manual	Same as SAIL III	
Light-UAS.2730		Recommended standard depends on the technology selected	No gaps	Same as SAIL III	

Table 156, Requirements covergave and gaps – Subpart G – Remote Crew Interface and Other Information

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8 Recommendations on regulatory aspects to be addressed

From the analysis presented in this document the following conclusions and recommendations can be made:

SORA

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

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

Given the above, it is recommended that:

- Some SORA criteria may become fully covered if standards under development indeed provide what is advertised in e.g. terms of reference or summaries; these standards should be assessed when they are published.
- The maturity of the standards will be continuously monitored to update the assessment.
- The coverage identified in this document is published by the project as the unique European Meta-Standard supporting the application of the SORA methodology for the specific category of operations.
- The European Commission, supported by EASA, should bring the gaps identified in section 3 to the attention of the European UAS Standard Coordination Group (EUSCG) to possibly initiate actions to fill the gap.

U-Space

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

- In case of gaps preventing full coverage, or where no standards are identified to provide at least partial coverage SDO's could discuss in the European UAS Standard Coordination Group (EUSCG) how to fill these.

- UTM in general and the U-space regulation assumes indirectly a connected environment. Further, UTM is based on a (automated) digital infrastructure connecting the different stakeholders exchanging in a (near-) real time manner information on planned operations, geo-graphical data,

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and ongoing manned and unmanned operations. A few examples of stakeholders are (but not limited to) UAS operators, USSP's, CIS(P), Traffic Information Service Providers and ATM service providers.

- The previous paragraphs have assessed several standards with respect to the several individual services described in regulation 2021/664. No standard, however, has been identified which fully suits and individual service or the U-space regulation. In case standards are retained, they only cover a small portion of a service or are originally not designed to serve the purpose and adaption of the standards might be recommended.
- Further the assessment methodology based on the individual review of standards and services poses a risk of incompatibility and fragmentation. Exchange of information, given the digital nature of the UTM infrastructure, happens at all levels and with multiple stakeholders for all the different services. The individual services and the stakeholders providing the several services should be considered as one ecosystem and not on an individual basis. To ensure compatibility and avoid fragmentation, it's advised that future standardisation efforts consider a larger framework and scope i.e. a set of UTM services including their proposed data formats and exchange mechanisms.
- Therefore, as suggestion, it might be useful to work closer with the individual SDO's to better coordinate and align the needs for standardisation.

SC-Light UAS

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

- In case of gaps preventing full coverage, or where no standards are identified to provide at least partial coverage SDO's could discuss in the European UAS Standard Coordination Group (EUSCG) how to fill them.

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9 References

[1] EASA (2019, AMC & GM to Commission Implementing Regulation (EU) 2019-947 - Issue 1
[2] AW-Drones (2019), D2.2: Methodology for the assessment of drone standards
[3] EASA (2017), Research Programme On Collision with Drones: Work Area 1 Final Report, Issue 4.0
[4] SJU (2016), SJU European Drones Outlook Study
[5] European Union (2019), Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft
[6] D4.3 AW-Drones Proposed Standard – 3rd iteration

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Annex 1 Standards' assessment

1. Complete Standards' Assessment for each SORA criterion:
   - D4.3 AW-Drones Proposed Standards – 3rd iteration (SORA)
   - https://docs.google.com/spreadsheets/d/11uESSLJR2ZoEfBbknuEUDDzZq1RFQ7WS

2. Complete Standards' Assessment for U-Space:
   - D4.3 AW-Drones Proposed Standards – 3rd iteration (U-Space)
   - https://docs.google.com/spreadsheets/d/1fiRKtQwjtLg3x8OyfiFA5hee8QEOIvr_

3. Complete Standards' Assessment for SC-Light UAS:
   - D4.3 AW-Drones Proposed Standards – 3rd iteration (SC-Light UAS)
   - https://docs.google.com/spreadsheets/d/1ju3nHVLk7BavTeYNUzQIaFpIU9ui1kZ8

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