Methodology for structuring and assessment of technical standards and related rules and procedures – final release

D2.3

AW-Drones

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AW-Drones

Abstract

AW-Drones aims at supporting the on-going rulemaking process in the European Union (EU) for the definition of common rules and identification of standards and procedures for civilian use of drones to enable safe, environmentally sound and reliable operations in the EU.

Work Package 3 of the AW-Drones project identifies industry consensus-based standards that are potentially suitable to serve as an Acceptable Means of Compliance (AMC) against drone regulations, as postulated by the "performance-based" approach to regulation. Subsequently Work Package (WP 4) assesses the suitability of these standards as AMC against drone regulations and the effect of not having a standard (i.e. a "gap") that could serve as AMC supporting a regulation. Also gaps in the available standards are identified (i.e. a standard may fulfil only partially a requirement). The assessment is performed using the methodology and assessment criteria developed by WP 2 and described in this document, which is the output of tasks 2.1 and 2.2 of the AW-Drones project.

The structuring methodology builds on safety objectives that are derived from relevant regulatory material. For the first two iterations in the project these are derivatives of:

- The published SORA[1] process (recommended by European Aviation Safety Agency EASA through AMC1 to Article 11 of Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft – Implementing Regulation 947); and
- The published opinion on U-space (Opinion 01/2020 High-level regulatory framework for the U-space) and draft texts of the associated proposed Commission Implementing Regulation, appendices and AMC & GM[2].

The assessment methodology is based on Multi-Criteria Analysis (MCA) which works as follows:

- A criterion represents the effect of a potential standard or lack of a standard on a certain aspect. Criteria are: maturity of standard, type of standard, effectiveness to fulfil Key Performance Area (KPA) requirement, cost of compliance, environmental impact, impact on EU Industry competitiveness, social acceptance;
- For each criterion a ranking system is defined which allows to express the magnitude of the effect of an option on the applicable aspect;

[1] Specific Operations Risk Assessment

[2] Guidance Material

- Rankings for the various criteria can have different units of measurements. To allow the combination of criteria, non-dimensional numerical scores are defined for each ranking system;
- The various criteria are combined by algebraically summing the scores of each criterion using a weight factor for each criterion. The weight factor expresses the importance of a criterion relative to the other criteria.

Feedback on the structuring and assessment methodology has been received from EASA during a workshop on 6-7 June 2019 at EASA in Cologne, during a workshop on 19 September 2019 at the European Organisation for the Safety of Air Navigation EUROCONTROL in Brussels, and was further refined after an Experts Review meeting on 27-29 January 2020 at EASA in Cologne.

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Acronyms

AEH	Airborne Electronic Hardware
AMC	Acceptable Means of Compliance
ANSP	Air Navigation Service Provider
ASTM	American Society for Testing and Materials
BVLOS	Beyond Visual Line Of Sight
C2	Command and Control
C3	Command, Control and Communications
CIS+	Common Information Service
ConOps	Concept of Operations
CSP	Communication Service Provider
CS-UAS	Certification Specifications – Unmanned Aircraft System
EASA	European Aviation Safety Agency
EC	European Commission
ERP	Emergency Response Plan
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAQ	Frequently Asked Questions
FCS	Flight Clearance Service
GM	Guidance Material
ISO	International Standards Organisation
KPA	Key Performance Area

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MCA	Multi-Criteria Analysis
N.A.	Not Applicable
NAA	National Aviation Authority
NIS	Network Identification Service
OSO	Operational Safety Objective
RIA	Regulatory Impact Assessment
RTCA	Radio Technical Commission for Aeronautics
SDO	Standard Development Organisation
SORA	Specific Operations Risk Assessment
SW	Software
TCRS	Tactical Conflict Resolution Service
UAS	Unmanned Aircraft System
USO	U-space Safety Objective
USSP	U-space Service Provider
VLOS	Visual Line Of Sight
WP	Work Package

1 Introduction

1.1 Purpose of this document

The purpose of this document is to describe the final validated methodology for both structuring and assessing the standards as identified in Work Package (WP) 3 of the AW-Drones project. It is the combined and final output of tasks 2.1 and 2.2 of the AW-Drones project.

1.2 Validation of methodologies

The methodology for both structuring and assessing the identified standards is validated on the basis of the following:

- Feedback internal to the project.
- Feedback from European Aviation Safety Agency EASA during a workshop on 6-7 June 2019 at EASA in Cologne.
- Feedback during a large stakeholder workshop on 19 September 2019 at European Organisation for the Safety of Air Navigation EUROCONTROL in Brussels.
- Feedback from an experts review meeting on 27-29 January 2020 at EASA in Cologne.

1.3 Structure of this document

The remainder of this document is structured as follows:

- Chapter 2 describes the methodology for structuring the standards for the Specific Operations Risk Assessment (SORA) and U-space
- Chapter 3 describes the methodology for assessing those standards.

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2 Methodology for structuring the standards

Ref. 1 identifies consensus-based technical standards and related procedures coming from industry, through Standard Development Organisations (SDOs). In the context of "Performance-Based Regulation" these standards may support the promulgated and on-going European Union's (EU's) common rules and related guidance material for civilian use of drones to enable safe, environmentally sound and reliable operations in the EU. The methodology for structuring the standards takes into account published or proposed (draft) regulatory material. For the first two iterations of the project these are the following:

- The published SORA process (recommended by EASA through AMC1 (Acceptable Means of Compliance) to Article 11 of Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft – IR 947); and
- The published opinion on U-space (Opinion 01/2020 High-level regulatory framework for the U-space) and proposed (draft) texts of the associated Commission Implementing Regulation, appendices and related AMC & GM[3].

From this regulatory material the requirements are derived and further detailed in Safety Objectives that are (potentially) to be supported by standards. Because of the fundamental differences between the published SORA process and the Opinion on U-space, the considered aspects for deriving the requirements are also different: section 2.1 describes the methodology for the SORA and section 2.2 for U-space. A graphical and condensed overview of this methodology is provided in appendix 1.

2.1 Methodology for structuring standards based on SORA requirements

The SORA process described in AMC1 to Article 11 of IR 947 comprises of 10 steps that identify air and ground risks, the Operational Safety Objectives (OSOs) to mitigate these risks to an acceptable level, and additional risk considerations:

- Mitigations for ground risk
- Air risk tactical mitigations
- Operational Safety Objectives
- Adjacent area/airspace considerations

[3] GM = Guidance Material

The mentioned EASA AMC1 breaks this down into the issues as listed in the table below.

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Component	Constituents	Objectives (potentially) to be supported by standards	Source
Mitigations for ground risk	M1 — Strategic mitigations for ground risk	This mitigation is meant as a means to reduce the number of people at risk considering tethered and non-tethered and should define the ground risk buffer and evaluation of people at risk	AMC1 to article 11, 2.3.2 footnote 10; Annex B to appendix A to article 11, B.2
	M2 — Effects of ground impact are reduced	This mitigation is meant as a means to reduce the energy absorbed by the people on the ground upon impact and could consider technical design, procedures and training	AMC1 to article 11, 2.3.2 footnote 11 Annex B to appendix A to article 11, B.2
	M3 — An emergency response plan (ERP) is in place, the UAS[4] operator is validated and effective	This mitigation considers training and procedures, for which the applicant should: (a) define a response plan for use in the event of a loss of control of the operation; (b) describe the procedures to limit the escalating effects of a crash; and (c) describe the procedures for use in the event of a loss of containment.	AMC1 to article 11, 2.3.2; Annex A to AMC1 to article 11, A.1.3.5; Annex B to appendix A to article 11, B.2
Air risk tactical mitigations	Tactical mitigations - VLOS[5]	Tactical mitigation whereby a pilot and/or observer uses (use) human vision to detect aircraft and take action to remain well clear from and avoid collisions with other aircraft. This is further	AMC1 to article 11, 2.4.1; Annex D to appendix A to AMC1 to article 11, D.5.1, D.5.2

[4] Unmanned Aircraft System

[5] Visual Line Of Sight

Component	Constituents	Objectives (potentially) to be supported by standards	Source
		detailed on de-confliction scheme and Phraseology, procedures and protocols	
	Tactical mitigations - BVLOS[6]	Tactical mitigation whereby an alternate means of mitigation to human vision, as in machine or machine assistance30, is applied to remain well clear from and avoid collisions with other aircraft (e.g. ATC separation services, TCAS, DAA, U-space, etc.). This is further detailed on the functions detect, decide, command, execute, feedback loop, integrity and assurance	AMC1 to article 11, 2.4.1; Annex D to appendix A to AMC1 to article 11, D.5.3.2
Operational Safety Objectives	OSO #01 — Ensure that the UAS operator is competent and/or proven	Through requiring sufficient knowledge of the UAS, operational procedures and risk assessments	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #02 — UAS designed and produced by a competent and/or proven entity	By requiring manufacturing procedures	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #03 — UAS maintained by competent and/or proven entity	Details maintenance -instructions, -staff requirements, -programs, -logs and –procedure manuals.	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #04 — UAS developed to authority recognised design standards	Mandates that the UAS is designed to standards considered adequate by the competent authority	Annex E to appendix A to AMC1 to article 11, E.2

[6] Beyond Visual Line Of Sight

Component	Constituents	Objectives (potentially) to be supported by standards	Source
	OSO #05 — UAS is designed considering system safety and reliability	Describes the required level of system safety and reliability analysis and type of failures to be considered.	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #06 — C3[7] link characteristics (e.g. performance, spectrum use) are appropriate for the operation	Considers the C2[8] link and any communication link required for the safety of the flight including performance requirements, actual performance and RF spectrum usage and environmental conditions that might affect the performance.	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #07 — Inspection of the UAS (product inspection) to ensure consistency with the ConOps[9]	Requires that remote crew ensures that the UAS is in a condition for safe operation and conforms to the approved ConOps by mandating procedures and training.	Annex E to appendix A to AMC1 to article 11, E.2
	OSO #08, OSO #11, OSO #14 and OSO #21 related to operational procedures	Considers operational procedures including procedure definition, complexity and consideration of potential human error.	Annex E to appendix A to AMC1 to article 11, E.3

[7] Command, Control and Communications

[8] Command and Control

[9] Concept of Operations

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Component	Constituents	Objectives (potentially) to be supported by standards	Source
	OSO #09, OSO #15 and OSO #22 related to remote crew training	Ensures that competency-based, theoretical and practical training is adequate for the operation.	Annex E to appendix A to AMC1 to article 11, E.4
	OSO #10 & OSO #12 related to safe design	Aims to complement the technical containment safety requirements by addressing the risk of a fatality while operating over populated areas or assemblies of people	Annex E to appendix A to AMC1 to article 11, E.5
	OSO #13 External services supporting UAS operations are adequate for the operation	It encompasses any service providers necessary for the safety of the flight, such as communication service providers (CSPs) and U-space service providers and ensures that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation.	Annex E to appendix A to AMC1 to article 11, E.6
	OSO #16 Multi crew coordination	Applies to those personnel directly involved in the flight operation and details crew procedures, training and communication devices.	Annex E to appendix A to AMC1 to article 11, E.7
	OSO #17 Remote crew is fit to operate	Ensures that crew is physically and mentally fit to perform their duties and safely discharge their responsibilities.	Annex E to appendix A to AMC1 to article 11, E.7
	OSO #18 Automatic protection of the flight envelope from human errors	Automatic protection of the flight envelope is intended to prevent the remote pilot from operating the UA outside its flight envelope.	Annex E to appendix A to AMC1 to article 11, E.7
	OSO #19 — Safe recovery from human errors	Addresses the risk of human errors which may affect the safety of the operation if not prevented or detected and recovered in a timely fashion by mandating procedures and checklists, training and design criteria.	Annex E to appendix A to AMC1 to article 11, E.7
	OSO #20 — A Human Factors evaluation has been performed	Requires that UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause	Annex E to appendix A to AMC1 to article 11, E.7

Component	Constituents	Objectives (potentially) to be supported by standards	Source
	and the HMI found appropriate for the mission	unreasonable fatigue, or contribute to remote crew errors that could adversely affect the safety of the operation.	
	OSO #23 — Environmental conditions for safe operations are defined, measurable and adhered to	Ensures it by requiring that environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document as procedures and that Training covers assessment of meteorological conditions.	Annex E to appendix A to AMC1 to article 11, E.8
	OSO #24 — UAS is designed and qualified for adverse environmental conditions (e.g. adequate sensors, DO-160 qualification)	Considers whether credit can be taken for the equipment environmental qualification tests / declarations, the suitability of the equipment for the intended/expected UAS environmental conditions can be determined from either in-service experience or relevant test results or considering any limitations which would affect the suitability of the equipment for the intended/expected UAS environmental conditions.	Annex E to appendix A to AMC1 to article 11, E.8
	TECHNICAL OSO	A generic technical objective detailing different levels of assurance for technical related OSOs	Annex E to appendix A to AMC1 to article 11, E.9
Adjacent area/airspace considerations	Adjacent area/airspace considerations	This addresses the risk posed by a loss of control of the operation, resulting in an infringement of the adjacent areas on the ground and/or adjacent airspace. It details the allowed probability of leaving the operational volume, the allowed failure of UAS or any external system supporting the operation and Software (SW) and airborne electronic hardware (AEH) development criteria	AMC1 to article 11, 2.5.3

Table 1: SORA breakdown

Standards are to be structured against the main components and constituent as detailed in Table 1.

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2.2 Methodology for structuring standards based on U-Space requirements

EASA Opinion No 01/2020 (Ref. 2) defines U-space as '*a set of services provided in a specific volume of airspace designated by the Member States to manage a large number of UAS operations in a safe and efficient manner*'[10]. It also proposes the following requirements:

- Articles 6 – 9 are general requirements for U-space Service Providers (USP) and for the operators of UAS and of manned aircraft operating in U-space airspace
- Articles 10 – 16 specify the U-space services subject to certification by the Aviation Authority
- Articles 6 and 7 provide high level principles for the required technical capabilities for utilising these U-space services
- Article 5 introduces the Common Information Service (CIS).

The risk assessment for U-space has not yet the level of maturity of the risk assessment in the SORA for the operations: for U-space there are no OSOs no mitigations, and no criteria for levels of robustness. An initial scan yielded that standards would be needed for Network Identification, Geo-awareness, Flight authorisation, Traffic information, Tracking, Weather, Conformance monitoring, Common Information Service, Occurrence Reporting and Contingency & Emergency Management. For each an AMC and the objectives that should be supported by standards shall be indicated. The table below derives a tentative list of U-space Safety Objectives (USOs) on basis of the requirements in Ref. 3.

[10] The original definition in the U space Blueprint (Ref. 4) is 'a set of new services and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones'. Because of these different definitions, one should be alert that a standard that is based on the definition in Ref. 4 may not fit in the definition in Ref. 2.

Article	Title	Objectives (potentially) to be supported by standards	Source
Chapter I — Principles and general requirements			
1	Subject matter and scope	N.A. because it only sets the scope	-
2	Objectives	N.A. because it only provides generic objectives	-
3	Definitions	N.A. because it only provides definitions	-
Chapter II — Establishment of the U-space			
4	Designation of U-space airspace	N.A.; Responsibility of States, through respective competent aviation authority and not of the U-Space Service Provider (USSP).	-
5	Common information service	The information provided by the CIS comes from trusted sources	GM1 to Article 5
		The information provided by the CIS is of sufficient quality, integrity, accuracy and security for other USSP's to provide their service	GM1 to Article 5
		The CIS provider ensures that all information can be exchanged between the various organisations to fulfil their obligations (i.e. interoperability based on common semantics)	GM1 to Article 5
Chapter III — General requirements for aircraft operators and U-space service providers			
6	UAS operators	In U-space airspace, the unmanned aircraft is technically capable of receiving the U-space services	GM1 to Article 6
		The UAS operator has contingency measures and procedures and makes these available to the USP , based on a Service Level Agreement	Article 6
7	Obligation for operators of manned aircraft operating in U-space airspace	In U-space airspace that is in uncontrolled airspace, manned aircraft provide their position at regular intervals, with the necessary level of performance in terms of integrity, accuracy, continuity, availability and security to the Tactical Conflict Resolution Service (TCRS)	GM1 to Article 7, plus TCRS identified by the CORUS project

Article	Title	Objectives (potentially) to be supported by standards	Source
8	U-space service providers	The CIS provides e.g. airspace restrictions, status of the airspace, available traffic information, based on common model for exchange of geographical data	GM1 to Article 8
		The USSP for Flight Clearance Service (FCS) is capable of checking a flight authorisation request for completeness, plausibility, and accuracy	GM1 to Article 8
		Any USSP is able to exchange information with the CIS based on a common interface protocol	GM1 to Article 8
		When necessary, the USSP is be able to exchange information with Air Traffic Service Providers (ATSP's)	GM1 to Article 8
		Any USSP provides the information with the necessary quality requirements and ensures the necessary protection	Article 8
9	Occurrence reporting	Any USSP reports occurrences based on the current regulation in civil aviation, as reflected in its procedures or manuals	GM1 to Article 9
Chapter IV — U-space services			
10	Network identification service	The Network Identification Service (NIS) operationally supports traffic safety and the traceability of an unmanned aircraft during respective flights	GM1 to Article 10
11	Geo-awareness service	The geo-awareness service provides UAS operators with geo-awareness with the level of accuracy and performance based on a common format to exchange geographical information	GM1 to Article 11
12	Flight authorisation service	Within controlled airspace, the U-space service provider coordinates the flight authorization (which is considered to be a clearance) requests with the relevant air traffic services	Article 12.2
		The flight authorisation service checks against airspace restrictions and limitations and de-conflicts from other traffic according to the priority rules	Article 12.4
13	Traffic information service	The traffic information service provides the alerts, air situation and known/predicted traffic to the UAS operator with the required level of detail, accuracy and update frequency	GM1 to Article 13

Article	Title	Objectives (potentially) to be supported by standards	Source
14	Tracking service	The tracking service fuses data from the different tracking sources into unique and reliable UAS flight tracks	GM1 to Article 14
15	Weather information service	The weather information service collects reliable specific weather information necessary to support UAS operational decisions and other U-space services	Article 15 GM1 to Article 15
16	Conformance monitoring service	The conformance monitoring service checks the current track of each UAS with respect to its planned mission, considers new geo-fencing areas and alerts when detecting non-conformities	GM1 to Article 16
Chapter V — CIS providers and U-space service providers certification			
17	Application for a CIS provider and U-space service provider certificate	N.A. because provides details of the certificates	-
18	Conditions for obtaining a certificate	The CIS provider is able to provide its services in a safe, efficient, continuous and sustainable manner, consistent with the level of service	Article 18.1
		The CIS provider uses systems and equipment that guarantee the quality, accuracy and integrity of the U-space services	Article 18.2
		The CIS provider has established an information security management system	Article 18.5
19	Validity of the certificate	N.A. because states the conditions of validity	-
Chapter VI — Competent authorities			
20	Competent authority	N.A. because it applies to authorities only	-

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Article	Title	Objectives (potentially) to be supported by standards	Source
21	Tasks of the competent authorities	N.A. because it applies to authorities only	-
22	Exchange of safety information and safety measures	N.A. because it applies to authorities only	-
Chapter VII — Pricing of CIS			
23	Pricing of common information service	N.A. because it addresses financial issues	-
Chapter VIII — Final provisions			
24	Amendments to Commission Implementing Regulation (EU) 2017/373	N.A. because it addresses a legal procedure	-
25	Entry into force and applicability	N.A. because it only sets a date independent from the requirements.	-

For each objective, the mapped standards may address a service, a capability (for systems that uses the services) or a resource to deliver the services (e.g. infrastructure); for each standard it should be indicated which of these it addresses. Since Ref. 2 includes requirements for manned aviation as well, also standards for manned aviation need to be considered.

As stated above, the table can only provide a tentative list of objectives because the AMCs for U-space are still under development. By lack of these AMCs it was agreed with EASA to only identify and assess standards for the two services that will be operational shortly, the Network identification service and the Geo-awareness service. Even more specifically, those standards are aimed to cover the aspects from a U-space service provider point of view.

3 Methodology for assessing the standards

This chapter is a replication of chapter 2 of AW-Drones deliverable D2.2 in which improvements, as found in the validation process (see section 1.2), are incorporated. As this process only included the SORA requirements an initial analysis on the suitability of this methodology for U-space standards is also performed. Based on this analysis no changes to the items hereunder are expected to be needed when addressing standards for U-Space.

In the assessment of each standard, three different cases will be considered:

- **CASE 1**: a standard that is potentially suitable to comply with a certain requirement has been identified (e.g. OSO #6);
- **CASE 2**: a standard that is potentially suitable to comply with a certain requirement(e.g. OSO #18) has not been identified;
- **CASE 3**: a standard that does not map on any requirement has been identified ("orphan" standard).

Note: during the first iteration of assessing the standards, CASE 3 will not be considered. It will be decided later whether to use CASE 3 for further iterations of assessing the standards.

The assessment methodology is based on the so called Multi-Criteria Analysis (see section 3.1).

The structured standards will be assessed in WP 3 of the AW-Drones project using an initial set of criteria:

- Maturity of standard
- Type of standard

Note: for case 2 these criteria are not applicable due to the lack of a standard.

Then the structured standards will be assessed in WP 4 of the AW-Drones project using a full set of criteria.

- Effectiveness to fulfil Key Performance Area (KPA) requirement
- Cost of compliance
- Environmental impact
- Impact on EU Industry competitiveness

These criteria, their scoring system, the weight factors and the conclusions based on the total scores are described in sections 3.4, 3.5 and 3.6 for CASE 1, CASE 2 respectively CASE 3.

3.1 Multi Criteria Analysis

Multi Criteria Analysis is an analytical method that is used to compare and rank options when the effects of an option on multiple aspects must be considered. For example the effect of a proposed new regulation on safety, cost, the environment and the society, or the effect of a proposed aircraft design solution on aircraft fuel consumption, system procurement cost, maintenance cost and training cost.

Multiple criteria Analysis works as follows:

- A criterion represents the effect of an option on a certain aspect such as safety, cost, the environment or the society.
- For each criterion a ranking system is defined which allows to express the magnitude of the effect of an option on the applicable aspect. The ranking system can be qualitative (e.g. very negative/negative/no effect/positive/very positive, low/medium/high) or quantitative (e.g. amount of euros, number of decibels, amount of particles per m^3).
- Rankings for the various criteria can have different units of measurements. To allow the combination of criteria, non-dimensional numerical scores are defined for each ranking system (e.g. very negative = 1, negative = 2, no effect = 3, positive = 5, very positive =5).
- The various criteria are combined by summing the scores of each criterion using a weight factor for each criterion. The weight factor expresses the importance of a criterion relative to the other criteria. (e.g. effect on safety has weight factor 3, effect on environment has weight factor 1, thus safety is considered more important than the impact on the environment).

EASA uses Multiple criteria Analysis in the so called Preliminary Rulemaking Impact Assessment which assesses the effects of possible regulatory options and the expected safety benefits in order to identify the preferred option[11].

The European Commission provides guidelines for impact assessment which are also structured around Multiple Criteria Analysis (see Ref. 5).

The Multi Criteria Analysis used by AW Drones is in line with the EASA pre-RIA[12] method as well as with the guidelines by the European Commission (EC).

3.2 Weight factors used

The weight factors for calculating the total score from the scores per individual criterion, and the rationale are as follows:

[11] The Preliminary Rulemaking Impact Assessment format and methodology is available via the EASA public website at the following link: http://easa.europa.eu/rulemaking/procedures-and-work-instructions.php). It was used for example in the Study on High Performance Aircraft (Ref. 6) which a consortium consisting of Ecorys and NLR performed on behalf of EASA.

[12] Regulatory Impact Assessment

Criterion	Weight factor	Rationale
Maturity of standard	2	A standard with a higher maturity is more easily applicable in the short term, thus the impact of this criterion is significant on the overall evaluation.
Type of standard	1	To differentiate between information guidance, best practice and certification specifications
Effectiveness to fulfil KPA requirement	3	Safety is considered the most important criterion.
Cost of compliance	2	Cost of compliance is considered the second most important criterion.
Environmental impact	1	To indicate whether this is expected to be bad, neutral or good.
Impact on EU Industry competitiveness	1	To indicate whether this is expected to be (very) negative, neutral or (very) positive.

Table 2: Weight factors for calculating the total score

Criteria can be disregarded by setting their weigh factor to zero. For example:

- It is questionable whether a rating for the criterion 'Social acceptance' can be determined in a reliable and repeatable way. Results from the project are awaited before it will be decided whether or not to use this criterion.

3.3 Differences in criteria for the three cases

The criteria for the three cases differ in the following manner:

For CASE 2, the criteria 'maturity of a standard' and 'type of standard' are not applicable because there is no standard.

The criterion 'effectiveness to fulfil KPA requirement' differs between the three cases as follows:

- CASE 1:
  In case of an incomplete coverage of a requirement by a standard, the applicant must demonstrate by other means that the requirement is met. There is a risk that missing aspects will be overlooked by either the applicant or the regulator. To quantify the effect on safety it is most conservatively

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assumed that the missing aspects are overlooked. Therefore partial coverage and full coverage of a requirement corresponds with a medium respectively large positive effect on safety.

- CASE 2:
  In case of missing standards the applicant must demonstrate by other means that the requirement is met. There is a risk that aspects will be overlooked by either the applicant or the regulator. Therefore missing standards have a negative or no impact on safety.
- CASE 3:
  A standard that does not map onto a requirement but seems useful nonetheless suggests that either the standard is not safety related or the requirements are incomplete (which will be analysed during the next phase of the project).

For CASE 2 ‘the cost of compliance with’, ‘the effect on the environment, ‘social acceptance’ of the regulation without having a standard, and the ‘effect on EU industry competiveness’ of the lack of a standard are considered.

3.4 CASE 1: a standard that is potentially suitable to comply with a certain requirement has been identified

This section contains the criteria and the scoring system for the assessment of the standards for CASE 1.

This section contains the criteria and the scoring system for the assessment of the standards for CASE 1. Table 3 shows the assessment criteria with corresponding weights, and Table 4 shows the scoring scales for the considered criteria.

Criterion	Description	Weight
Maturity of standard	Although the exact wording may differ, all organisations/groups involved in making standards apply a similar process, or work flow (Ref. 7 - 10). In essence they all follow the approach of: Planning, Drafting, Internal Consultation, External Consultation, and Published. • Drafting: is considered to be the phase in which a person or (small) team of persons has actually started working on drafting the standard. • Internal Consultation: is considered to be the phase in which a (first) draft of the standard is provided to a higher body within that same organisation for review and/or approval (thus a sub group provides a draft to a working group or a working group provides a draft in a plenary meeting). In case no (internal) status updates for a standard are provided the status of that standard will remain 'Drafting' until it's published for external consultation. After the internal consultation review/comments are gathered the draft standard may be revised to address the comments. For this rating process the status will remain at 'internal consultation' up to and including this revision period. • External Consultation: After internal consultation and internal approval it is good practice to issue the draft standard for external consultation. After the external consultation review/comments are gathered the draft standard may be revised to address the comments. For this rating process the status will remain at 'external consultation' up to and including this revision period. • Published: Once all external consultation comments are addressed, either by revising the standard text or provide a clarification or rationale on that specific comment, the standard can be published either after ratification or other form of approval or directly. For this rating process the status is only changed to published once the standard is classified as Final and that standard is available in the public domain (either free of charge or at charges). • Recognised / accepted / used: published standards that are actually used by applicants. In specific cases in which no status updates can be found or obtained for a specific standard (i.e. it cannot be verified in which of the above stages the standard is) that standard is rated as planned and is changed to published once that standard is available in the public domain (either free of charge or at charges). Standards will be checked on maturity just before drafting the respective deliverable and the status will be frozen at that moment.	2

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Criterion	Description	Weight
Type of standard	The type of the standard is considered to be a measure for the applicability of that standard. For this purpose three types of standards are identified: • Information guidance: A standard with non-binding explanatory and interpretation material (including examples) on how to achieve, interpret and/or apply the requirements contained in a specific or sets of rule(s) and/or regulation(s) (based on ref: EASA FAQ[13] n. 19026[14]) • Best practice: A standard that has proven to lead to a desired result in a repetitive (reliable) way. If this cannot be substantiated by research and/or documented experience, the standard should be rated as information guidance. • Standard Specification: A standard that could be proposed as an acceptable means of compliance (EASA FAQ n.19026) to a specific rule or regulation.	1
Effectiveness to fulfil KPA requirement	This criterion will address the effectiveness of the candidate standard to fulfil a given requirement with respect with its relevant Key Performance Area (e.g. Safety, Security) The primary material on which the assessment of a standard will be performed will be the beginning of the standardisation document, i.e. sections such as the abstract, scope, applicability and background information. It will be assessed to what extent the standard covers a requirement: not applicable, partial or full coverage. In case of an incomplete coverage the applicant must demonstrate by other means that the requirement is met. There is a risk that missing aspects will be overlooked by either the applicant or the regulator. At this stage, it is conservatively assumed that the missing aspects are overlooked. Therefore partial coverage and full coverage of a requirement corresponds with respectively a neutral and positive effect on KPAs. In case of partial coverage of a requirement the gaps must be indicated.	3

[13] Frequently Asked Questions

[14] https://www.easa.europa.eu/faq/19026; URL verified 23 June 2020

Criterion	Description	Weight
Cost of compliance	The objective of this criterion is mainly to assess and quantify the feasibility and practicability for the drone industry of adopting a certain standard. Cost of compliance is a metric to measure them. All costs incurred to comply with the selected standard shall be identified and quantified at a qualitative level. The analysis should consider all affected stakeholders such as: Manufacturers, Maintenance organisations, Training organisations, Operator organisations, Remote pilots, Regulators, Oversight authorities, General public. The assessment should include (as a minimum): • Development costs incurred to develop a product/system compliant with the standards (e.g. Cost for manufacturers to develop a DAA compliant with EUROCAE/RTCA standard, or an entire UAS compliant with CS-UAS or ISO UAS product standard. Cost for training organization to develop a training course compliant with ASTM standard, cost for Remote Pilots to get a license) • Operational costs related to the limitations coming from the applicability of the selected standard (e.g. if a standard is applicable only to operations in uncontrolled airspace, there is a cost for the operator that cannot fly in controlled airspace. If a standard is applicable only to rotorcraft, there is a cost related to the efficiency of operations requiring to fly long distances and more suitable for fixed-wing drones) • Time required to complete the development of all products/systems/infrastructures required to comply with the selected standard (e.g. time for Remote Pilots to obtain a license in line with a selected training standard, time for manufacturers to implement production processes that allows to produce UAS compliant with CS-UAS) • Compatibility/consistency with existent standards should be considered as a way to reduce overall costs by possibly reusing products/systems/technologies already developed. • Both one-off and recurring costs shall be identified. All the costs and resources listed here should be measured or derived with an expert judgement taking into consideration the different magnitude and business case of the considered stakeholders. Costs considerations will cover the sustainability and feasibility of the adoption of the considered standard for a certain organization, rather than the absolute value of the sustained costs (e.g. Airbus and DJI may have very different costs for the production of a certain component but with a similar affordability within their respective business cases).	2
Environmental impact	Effects on emission of greenhouse gases; noise nuisance; energy and fuel consumption. Effect on areas, scenic view, and resources. Likelihood of causing fires, explosions or accidents. Effects on (local) fauna. Impact can be bad, neutral or good. For example, a standard directed at reducing consumption of resources has a beneficial impact. On the other hand, a standard may be harmful when, for instance, it induces high noise nuisance or fuel consumption. Standards are expected to have mostly a neutral impact.	1

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Criterion	Description	Weight
Impact on EU Industry competitiveness	This criterion defines the impact (both positive and negative) of the adoption of the selected standard on EU industrial stakeholders (manufacturers, operators, service providers, etc.) competitiveness. The analysis should consider all affected stakeholders and include (as a minimum): • Cost of compliance specifically for the European stakeholders (high costs mean a negative impact); • Readiness of EU industry in adopting the standard (long times for adoption lead to a negative impact) • Readiness of EU aviation authorities (EASA and NAAs[15]) in adopting the standard (long times for adoption lead to a negative impact) • Potential benefits for EU manufacturers of certifiable technologies (positive impact) or need to rely on non-EU manufacturers to integrate certifiable technology (negative impact) • Both one-off and recurring costs and benefits for EU industry shall be identified.	1

Table 3: Criteria for CASE 1

Item	-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Maturity of standard	Drafting	Internal Consult.	External Consult.	Published	Recognized / Accepted / Used
Type of standard	N.A.[16]	N.A.	Information Guidance	Best Practice	Standard Specification
Effectiveness to fulfil KPA requirement	N.A.	N.A.	Partial coverage	N.A.	Full coverage

[15] National Aviation Authorities

[16] Not Applicable

Item	-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Cost of compliance	Very High	High	Medium	Low	Very Low
Environmental impact	Bad	N.A.	Neutral	N.A	Good
Impact on EU Industry competitiveness	Very negative	Negative	No impact	Positive	Very Positive

Table 4: Criteria and scoring system (CASE 1)

Each rating must be accompanied by a rationale.

3.4.1 Conclusions based on weighted score

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

- A standard that corresponds with a requirement and has a high score (see figure 1) will be proposed as AMC. In case of partial coverage the gaps will be indicated.
- A standard that correspond with a requirement that has a medium score (see figure 1) will be listed as possible AMC subject to decision by Authority. In case of partial coverage the gaps will be indicated.
- For a standard that corresponds with a requirement and has a low score (see figure 1), possible applicable standards from manned aviation and other industries will be proposed, or a recommendation to amend the standard will be provided. In case of partial coverage the gaps will be indicated.

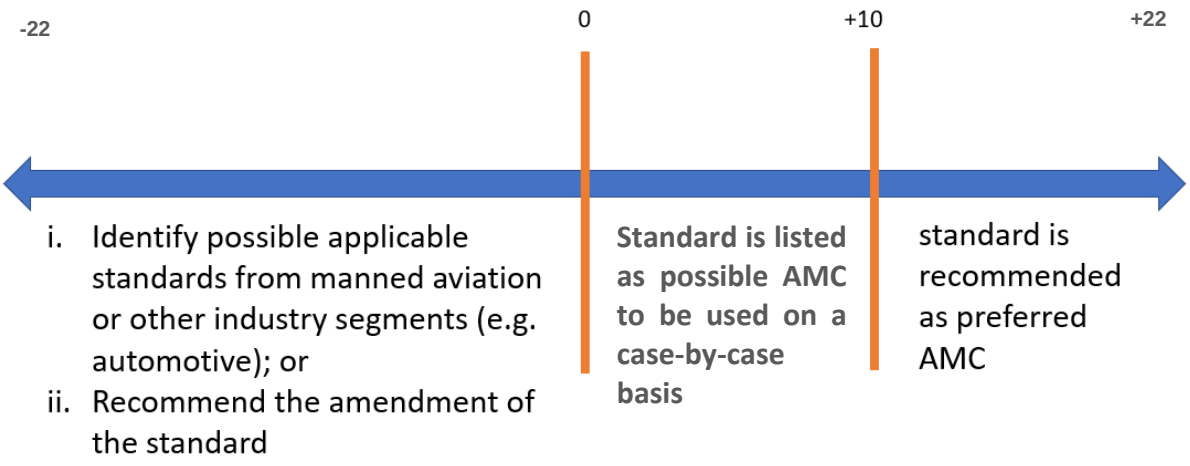

Figure 1, Conclusions for CASE 1 based on weighted score

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3.5 CASE 2: a standard that is potentially suitable to comply with a certain requirement has not been identified

This section contains the criteria and the scoring system for the assessment of the standards for CASE 2.

This section contains the criteria and the scoring system for the assessment of the standards for CASE 2. The criteria are given in Table 5 and scoring scales in Table 6.

Criterion	Description	Weight
Safety (or other reference KPA) impact	In case of missing standards the applicant must demonstrate by other means that the requirement is met. The objective of this criterion is mainly to assess and quantify the impact on Safety (or other relevant KPAs) of the need of complying with the identified requirement with no definition of adequate standards. There is a risk that aspects will be overlooked by either the applicant or the regulator. Therefore missing standard might have a negative impact on safety (or other relevant KPAs).	3
Cost of compliance (to the requirement with a lack of standard)	The objective of this criterion is mainly to assess and quantify the feasibility and practicability for the drone industry of complying with the identified requirement with no definition of adequate standards. Cost of compliance is a metric to measure it. All costs incurred to comply with the selected requirement shall be identified and quantified at a qualitative level. The analysis should consider all affected stakeholders such as: Manufacturers, Maintenance organisations, Training organisations, Operator organisations, Remote pilots, Regulators, Oversight authorities, General public. The assessment should include (as a minimum): • Development costs incurred to develop a product/system that fulfils the selected requirement without guidance from existing standards • Operational costs related to the limitations incurred to comply with the selected requirement without a reference standard • Time required to complete the development of all products/systems/infrastructures required to comply with the selected requirement • Both one-off and recurring costs shall be identified. All the costs and resources listed here should be measured or derived with an expert judgement taking into consideration the different magnitude and business case of the considered stakeholders. Costs considerations will cover the sustainability and feasibility of complying with the requirement for a certain organization, rather than the absolute value of the sustained costs (e.g. Airbus and DJI may	2

Criterion	Description	Weight
	have very different costs for the production of a certain component but with a similar affordability within their respective business cases).	
Environmental impact	Effects of lack of a standard on emission of greenhouse gases; noise nuisance; energy and fuel consumption. Effect on areas, scenic view, and resources. Likelihood of causing fires, explosions or accidents. Effects on (local) fauna. The effect of a lack of a standard is expected to have mostly a neutral impact.	1
Impact on EU Industry competitiveness -	This criterion defines the impact (both positive and negative) of the lack of standards for the considered requirement on EU industrial stakeholders (manufacturers, operators, service providers, etc.) competitiveness. The analysis should consider all affected stakeholders and include (as a minimum): • Cost of compliance to the requirement specifically for the European stakeholders in absence of suitable standards (high costs mean a negative impact); • Readiness of EU industry in proposing suitable standards for the selected requirement (long times for proposal lead to a negative impact) • Impact for EU aviation authorities (EASA and NAAs) of having a regulatory framework that is not covered by suitable standards for the selected requirement • Impact for the EU market of having a regulatory framework that is not covered by suitable standards for the selected requirement • Both one-off and recurring costs and benefits for EU industry shall be identified.	1

Table 5: Criteria for CASE 2

Item	-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Safety (or other reference KPA) impact	Very High	High	Medium	Low	Very Low
Cost of compliance (to the requirement with a lack of standard)	Very High	High	Medium	Low	Very Low

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Item	-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Environmental impact	Bad	N.A.	Neutral	N.A	Good
Impact on EU Industry competitiveness	Very negative	Negative	No impact	Positive	Very Positive

Table 6: Criteria and scoring system (CASE 2)

Each rating must be accompanied by a rationale.

3.5.1 Conclusions based on weighted score

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

- For a requirement that has no corresponding standards (gaps) and a low score (see figure 2), possible applicable standards from manned aviation and other industries will be proposed (e.g. standards applicable to navigation receivers for the automotive industry or standards for mobile telephony). Or a recommendation to develop a suitable standard will be provided.

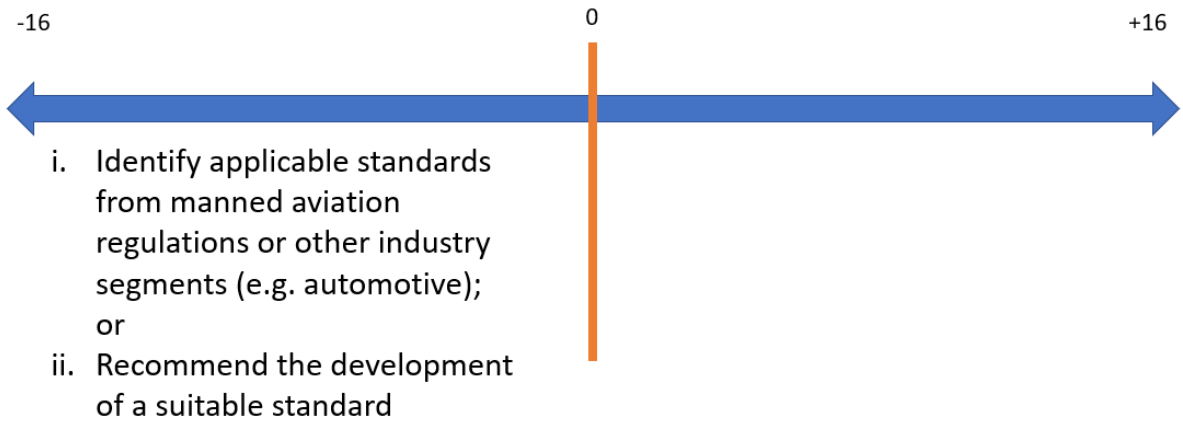

Figure 2, Conclusions for CASE 2 based on weighted score

3.6 CASE 3: a standard that does not map on any requirement has been identified

This section contains the criteria and the scoring system for the assessment of the standards for CASE 3. The criteria are given in Table 7 and the corresponding scoring system in Table 8.

Criterion	Description	Weight
Maturity of standard	Although the exact wording may differ, all organisations/groups involved in making standards apply a similar process, or work flow (Ref. 7 - 10). In essence they all follow the approach of: Planning, Drafting, Internal Consultation, External Consultation, and Published. • Drafting: is considered to be the phase in which a person or (small) team of persons has actually started working on drafting the standard. • Internal Consultation: is considered to be the phase in which a (first) draft of the standard is provided to a higher body within that same organisation for review and/or approval (thus a sub group provides a draft to a working group or a working group provides a draft in a plenary meeting). In case no (internal) status updates for a standard are provided the status of that standard will remain 'Drafting' until it's published for external consultation. After the internal consultation review/comments are gathered the draft standard may be revised to address the comments. For this rating process the status will remain at 'internal consultation' up to and including this revision period. • External Consultation: After internal consultation and internal approval it is good practice to issue the draft standard for external consultation. After the external consultation review/comments are gathered the draft standard may be revised to address the comments. For this rating process the status will remain at 'external consultation' up to and including this revision period. • Published: Once all external consultation comments are addressed, either by revising the standard text or provide a clarification or rationale on that specific comment, the standard can be published either after ratification or other form of approval or directly. For this rating process the status is only changed to published once the standard is classified as Final and that standard is available in the public domain (either free of charge or at charges). • Recognised / accepted / used: published standards that are actually used by applicants. In specific cases in which no status updates can be found or obtained for a specific standard (i.e. it cannot be verified in which of the above stages the standard is) that standard is rated as planned and is changed to published once that standard is available in the public domain (either free of charge or at charges). Standards will be checked on maturity just before drafting the respective deliverable and the status will be frozen at that moment.	1
Type of standard	The type of the standard is considered to be a measure for the applicability of that standard. For this purpose three types of standards are identified: • Information guidance: A standard with non-binding explanatory and interpretation material (including examples) on how to achieve, interpret	1

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Criterion	Description	Weight
	and/or apply the requirements contained in a specific or sets of rule(s) and/or regulation(s) (based on ref: EASA FAQ n. 19026[17]) • Best practice: A standard that has proven to lead to a desired result in a repetitive (reliable) way. If this cannot be substantiated by research and/or documented experience, the standard should be rated as information guidance. • Standard Specification: A standard that could be proposed as an acceptable means of compliance (EASA FAQ n.19026) to a specific rule or regulation.	
Impact on relevant KPA	This criterion addresses the potential benefit given by the compliance to the considered standard in absence of a corresponding requirement. The criterion assesses the impact on the KPAs for which the standard has been produced (e.g. Safety, Security). A standard that does not map onto a requirement but seems useful nonetheless suggests that either the standard is not safety related or the requirements are incomplete.	3
Cost of compliance	The objective of this criterion is mainly to assess and quantify the feasibility and practicability for the drone industry of adopting a certain standard. Cost of compliance is a metric to measure them. All costs incurred to comply with the selected standard shall be identified and quantified at a qualitative level. The analysis should consider all affected stakeholders such as: Manufacturers, Maintenance organisations, Training organisations, Operator organisations, Remote pilots, Regulators, Oversight authorities, General public. The assessment should include (as a minimum): • Development costs incurred to develop a product/system compliant with the standards (e.g. Cost for manufacturers to develop a DAA compliant with EUROCAE/RTCA standard, or an entire UAS compliant with CS-UAS or ISO UAS product standard. Cost for training organization to develop a training course compliant with ASTM standard, cost for Remote Pilots to get a license) • Operational costs related to the limitations coming from the applicability of the selected standard (e.g. if a standard is applicable only to operations in uncontrolled airspace, there is a cost for the operator that cannot fly in controlled airspace. If a standard is applicable only to rotorcraft, there is a cost related to the efficiency of operations requiring to fly long distances and more suitable for fixed-wing drones) • Time required to complete the development of all products/systems/infrastructures required to comply with the selected standard (e.g. time for Remote Pilots to obtain a license in line with a selected	2

[17] https://www.easa.europa.eu/faq/19026; URL verified 23 June 2020

Criterion	Description	Weight
	training standard, time for manufacturers to implement production processes that allows to produce UAS compliant with CS-UAS) • Compatibility/consistency with existent standards should be considered as a way to reduce overall costs by possibly reusing products/systems/technologies already developed. • Both one-off and recurring costs shall be identified. All the costs and resources listed here should be measured or derived with an expert judgement taking into consideration the different magnitude and business case of the considered stakeholders. Costs considerations will cover the sustainability and feasibility of the adoption of the considered standard for a certain organization, rather than the absolute value of the sustained costs (e.g. Airbus and DJI may have very different costs for the production of a certain component but with a similar affordability within their respective business cases).	
Environmental impact	Effects on emission of greenhouse gases; noise nuisance; energy and fuel consumption. Effect on areas, scenic view, and resources. Likelihood of causing fires, explosions or accidents. Effects on (local) fauna. Impact can be beneficial, neutral or harmful. For example, a standard directed at reducing consumption of resources has a beneficial impact. On the other hand, a standard may be harmful when, for instance, it induces high noise nuisance or fuel consumption. Standards are expected to have mostly a neutral impact.	1
Impact on EU Industry competitiveness	This criterion defines the impact (both positive and negative) of the adoption of the selected standard on EU industrial stakeholders (manufacturers, operators, service providers, etc.) competitiveness. The analysis should consider all affected stakeholders and include (as a minimum): • Cost of compliance specifically for the European stakeholders (high costs mean a negative impact); • Readiness of EU industry in adopting the standard (long times for adoption lead to a negative impact) • Readiness of EU aviation authorities (EASA and NAAs) in adopting the standard (long times for adoption lead to a negative impact) • Potential benefits for EU manufacturers of certifiable technologies (positive impact) or need to rely on non-EU manufacturers to integrate certifiable technology (negative impact) • Both one-off and recurring costs and benefits for EU industry shall be identified.	1

Table 7: Criteria for CASE 3

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Item	-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Maturity of standards	Drafting	Internal Consult.	External Consult.	Published	Recognized / Accepted / Used
Type of standard	N.A.	N.A.	Information Guidance	Best Practice	Standard Specification
Impact on relevant KPA	N.A.	N.A.	No impact	N.A.	Positive Impact
Cost of compliance	Very High	High	Medium	Low	Very Low
Environmental impact	Bad	N.A.	Neutral	N.A	Good
Impact on EU Industry competitiveness	Very negative	Negative	No impact	Positive	Very Positive

Table 8: Criteria and scoring system (CASE 3)

Each rating must be accompanied by a rationale.

3.6.1 Conclusions based on weighted score

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

- For a standard that does not correspond with any requirement and has a high ranking, a new requirement will be proposed to match this standard.

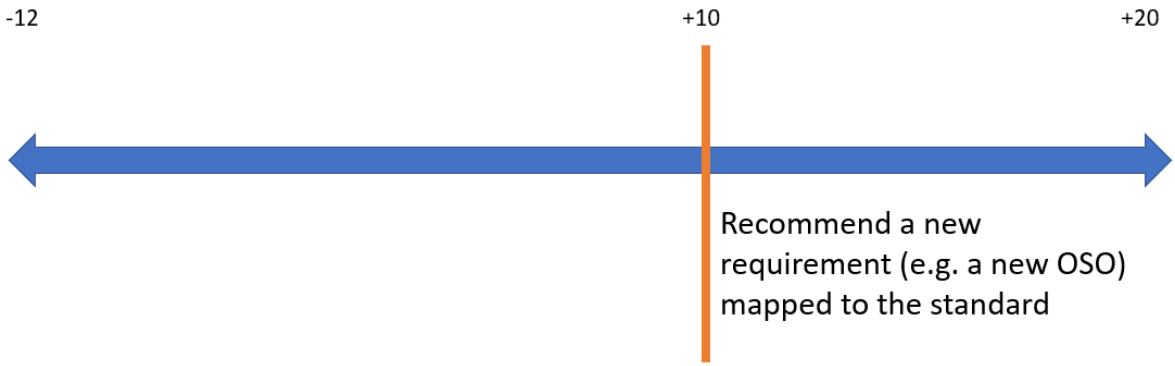

Figure 3, Conclusions for CASE 3 based on weighted score

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4 References

1 AW Drones WP3 table of identified standards; document internal to the project

2 EASA Opinion No 01/2020 'High-level regulatory framework for the U-space'

3 Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947 of 24 May 2019, issue 1 of 9 October 2019

4 U-Space Blueprint, SESAR Joint Undertaking, 2017 (https://www.sesarju.eu/u-space-blueprint; URL verified 23 June 2020)

5 European Commission, Impact Assessment Guidelines, SEC(2009) 92, 15 Jan 2009

6 Study on High Performance Aircraft, Ecorys, Specific contract No SC004 (SAP: 500007063) implementing framework contract No. EASA.2011.FC25, Final Report, Version 2.0, 14 November 2016

7 EASA Management Board Decision N° 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications, acceptable means of compliance and guidance material ('Rulemaking Procedure'). (https://www.easa.europa.eu/sites/default/files/dfu/EASA%20MB%20Decision%2018-2015%20on%20Rulemaking%20Procedure.pdf; URL verified 23 June 2020)

8 JARUS (http://jarus-rpas.org/sites/jarus-rpas.org/files/imce/attachments/jarus_tor_v06.17_and_annex_scb_tor_130818.pdf)

9 ISO :Proposal Stage* / Preparatory stage / Committee stage / Enquiry stage* / Approval stage / Publication stage* (https://www.iso.org/stages-and-resources-for-standards-development.html; URL verified 23 June 2020)

10 EUROCAE EUROCAE Technical Work Programme Edition 2019 (https://www.eurocae.net/media/1567/eurocae-public-twp-2019.pdf; URL verified 23 June 2020)

Appendix 1 Methodology for structuring the standards – graphical representation

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Methodology for structuring the requirements
General
SORA
U-space
Identify the reference regulatory material
AMC1 to Article 11 of Commission Implementing Regulation (EU) 2019/947 of 24 May 2019
Opinion 01/2020 High-level regulatory framework for the U-space
Identify relevant components from the reference material
Mitigations for ground risk
Air risk tactical mitigations
Operational Safety Objectives
Adjacent area/airspace considerations
Establishment of the U-space
General requirements for aircraft operators and U-space service providers
U-space services
CIS providers and U-space service providers certification
Identify Safety Objectives that support the components and are potentially to be supported by standards
Mitigations for ground risk
M1, M2, M3
Air risk tactical mitigations
VLOS, BVLOS
Operational Safety Objectives
OSO1 – OSO24
Adjacent area/airspace considerations
probability of leaving the operational volume, allowed failure of UAS or any external system supporting the operation and Software (SW) and airborne electronic hardware (AEH) development criteria
Establishment of the U-space
Common information service
General requirements for aircraft operators and U-space service providers
UAS operators, Obligation for operators of manned aircraft operating in U-space airspace U-space service providers
Occurrence reporting
U-space services
(Network identification service - Conformance monitoring service)
CIS providers and U-space service providers certification
Conditions for obtaining a certificate

Appendix 2 Methodology for assessing the standards – graphical representation

Methodology for assessing the requirements			
MCA	Case 1 Potential standard is identified	Case 2 Missing standards	Case 3 Potential useful standard not mapped to requirement
Maturity	Rate standard on Maturity	Rate impact of missing standard on Safety	To be developed in a later stage
Type	Rate standard on Type	Rate impact of missing standard on Cost	
Effectiveness	Rate standard on Effectiveness	Rate impact of missing standard on Environmental impact	
Cost	Rate standard on Cost	Rate impact of missing standard on Industry competitiveness	
Environmental impact	Rate standard on Environmental impact		
Industry competitiveness	Rate standard on Industry competitiveness		

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