This project has received funding from the European Union's Horizon Europe Programme

SHEPHERD

EASA.2022.C05

D2.1-D3.1

Identification of satisfactory industry standards and justification for not acceptable industry standards

An Agency of the European Union

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DELIVERABLE NUMBER AND TITLE:	D2.1-D3.1 Identification of satisfactory industry standards and justification for not acceptable industry standards
CONTRACT NUMBER:	EASA.2022.C05
CONTRACTOR / AUTHOR:	SHEPHERD consortium
IPR OWNER:	European Union Aviation Safety Agency
DISTRIBUTION:	Public

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DATE: 30.04.2023

SUMMARY

This document provides the outcome of the preliminary high-level assessment and subsequent detailed technical assessment conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the suitability of approximately half of the standards within the scope of the project in fulfilling the relevant requirements.

For each of the standards, it identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standards that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

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ABBREVIATIONS

ACRONYM	DESCRIPTION
ABAS	Aircraft-Based Augmentation System
ACAI	Availability, Continuity, Accuracy & Integrity
AEH	Airborne Electronic Hardware
AMC	Acceptable Means of Compliance
AMSL	Above Mean Sea Level
ARAIM	Advanced Receiver Autonomous INtegrity Monitoring
ARC	Air Risk Class
ATC	Air Traffic Control
ATS	Automatic Triggering System
BVLOS	Beyond Visual Line Of Sight
CRM	Crew Resource Management
CIS	Common Information Service
CS	Certification Specification
CU	Command Unit
C2	Command and Control
DAA	Detect and Avoid
DAL	Development Assurance Level
DUT	Device Under Test
EASA	European Union Aviation Safety Agency
EGNOS	European Geostationary Navigation Overlay Service
ERP	Emergency Response Plan
EU	European Union
EUSCG	European UAS Standards Coordination Group
E2E	End-to-End
FAA	Federal Aviation Administration
FH	Flight Hour
FHA	Functional Hazard Assessment
FMEA	Failure Modes and Effects Analysis
ft	Feet
FTE	Flight Technical Error
GBPT	GNSS-Based Positioning Terminal
GM	Guidance Material
GMM	General Maintenance Manual
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRC	Ground Risk Class
HAS	High-Accuracy Service
HMI	Human-Machine Interface

HW	Hardware
ICAO	International CIvil Aviation Organization
ICD	Interface Control DOcument
ID	Identification
IEC	International Electrotechnical Commission
IR	Implementing Regulation
IS	Interface Specification
ISO	International Organization for Standardization
ITS	Intelligent Transport System
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
km	Kilometre
kt	Knot
lb	Pound
MALE	Medium Altitude Long Endurance
MASPS	Minimum Aviation System Performance Standards
MCC	Multi-Crew Coordination
MIT	Massachusetts Institute of Technology
MIT LL	MIT Lincoln Laboratory
MoC	Means of Compliance
MOPS	Minimum Operational Performance Standards
MTOM	Maximum Take-Off Mass
MTOW	Maximum Take-Off Weight
NAA	National Aviation Authority
NMA	Navigation Message Authentication
NSE	Navigation System Error
N/A	Not Applicable
OS	Open Service
OSED	Operational Services and Environmental Description
OSO	Operational Safety Objective
PDE	Path Definition Error
PPP	Precise Point Positioning
PSS	Performance Standards & Specifications
PVT	Position – Velocity – Time
RAIM	Receiver Autonomous Integrity Monitoring
RDP	Rolling Development Plan
REQ	Requirement
RF	Radio Frequency
RPAS	Remotely Piloted Aircraft System
RTCA	Radio Technical Commission for Aeronautics
RTK	Real Time Kinematic
R&R	Record and Replay
SAIL	Specific Assurance and Integrity Level
SARPS	Standards and Recommended Practices

SBAS	Satellite-Based Augmentation System
SC	Special Condition
SDD	Service Definition Document
SDO	Standards Developing Organisation
SG	Subgroup
SHEPHERD	Standards Evaluation Project supporting European Regulations for Drones
SIS	Signal-In-Space
SoL	Safety of Life
SORA	Specific Operations Risk Assessment
SPS	Standard Positioning Service
STS	Standard Scenario
sUAS	Small Unmanned Aircraft System
SW	Software
TEM	Threat Error Management
TMPR	Tactical Mitigation Performance Requirement
TOR	Terms Of Reference
TSE	Total System Error
TST	Test
TTFF	Time To First Fix
T-UAV	Tactical Unmanned Aerial Vehicle
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UFM	Unmanned Aircraft Flight Manual
US	United States
USSP	U-space Service Provider
VTOL	Vertical Take-Off and Landing
V2V	Vehicle-to-Vehicle
WG	Working Group

1. Introduction

This document provides the outcome of the preliminary high-level assessment and subsequent detailed technical assessment conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the suitability of more than twenty standards in fulfilling the relevant requirements. The assessed standards, which involve approximately half of the standards within the scope of SHEPHERD, are the following ones:

ID	SDO	Reference	Version	Title
1	ASTM	F2483-18	2018	Standard Practice for Maintenance and the Development of Maintenance Manuals for Light Sport Aircraft
2	ASTM	F2908-18	2018	Standard Specification for Unmanned Aircraft Flight Manual (UFM)
3	ASTM	F2909-19	2019	Standard Practice for Maintenance and Continued Airworthiness of Small Unmanned Aircraft Systems (sUAS)
4	ASTM	F3266-18	2018	Standard Guide for Training for Remote Pilot in Command of Unmanned Aircraft Systems (UAS) Endorsement
5	ASTM	F3298-19	2019	Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems (UAS)
6	ASTM	F3309/F3309M-21	2021	Standard Practice for Simplified Safety Assessment of Systems and Equipment in Small Aircraft
7	ASTM	F3322-18	2018	Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes
8	ASTM	F3330-18	2018	Standard specification for Training and the Development of Training Manuals for the UAS Operator
9	ASTM	F3366-19	2019	Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)
10	ASTM	F3379-20	2020	Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement
11	ASTM	F3411-22a	2022	UAS Remote ID and Tracking
12	ASTM	F3442/F3442M-20	2020	Detect and Avoid performance Requirements
13a	EUROCAE	ED-12C	2012	Software Considerations in Airborne Systems and Equipment Certification
13b	EUROCAE	ED-80	2000	Design Assurance Guidance for Airborne Electronic Hardware

14	EUROCAE	ED-269	2020	Minimum Operational Performance Standard (MOPS) for Geo-Fencing
15	EUROCAE	ED-270	2020	Minimum Operational Performance Standard (MOPS) for Geo-Caging
16	EUROCAE	ED-279	2020	Generic Functional Hazard Assessment (FHA) for UAS/RPAS
17	EUROCAE	ED-280	2020	Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
18	EUROCAE	ED-282	2022	Minimum Operational Performance Standards (MOPS) for UAS E-Reporting
19	EUROCAE	ED-301	2022	Guidelines for the Use of Multi-GNSS Solutions for UAS Specific Category – Low Risk Operations SAIL I & II
20	ISO	ISO 16803-1:2016	2016	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS). Part 1: Definitions and system engineering procedures for the establishment and assessment of performance
21	ISO	ISO 16803-2:2016	2016	Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS). Part 2: Assessment of basic performances of GNSS-based positioning terminals
22	ISO	ISO 23665:2021	2021	Unmanned Aircraft Systems – Training for personnel involved in UAS operations
23	RTCA	DO-365A	2020	Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems - Phase 1

For each of the standards above, this document identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the relevant requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standards that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

2. Main considerations and assumptions

2.1 General

- The list of standards and associated requirements within the scope of SHEPHERD was built upon the work performed and deliverables published by the AW-Drones project, and aligned with the Unmanned Aircraft Systems (UAS) Rolling Development Plan (U-RDP) of the European UAS Standards Coordination Group (EUSCG).
- The standards already recognised by EASA as suitable standards for the SORA requirements, U-space regulation, and SC Light-UAS through MoC or AMC & GM have not been re-assessed by SHEPHERD and are, therefore, considered out of scope of the project.
- The assessment criteria and work methodology ensuring impartial, systematic, and consistent evaluation of standards developed by SHEPHERD have been rigorously applied.

2.2 Requirements

- The SORA requirements' wording and content are those of SORA v2.5 published by JARUS for external consultation in December 2022, except for the numbering of the OSOs, which follows SORA v2.0 instead.
- Both SC Light-UAS medium- & high-risk requirements have been considered.
- As SC Light-UAS provisions are limited to UAS with a MTOM of up to 600 kg, unlike the requirements contained in SORA, which does not provide any mass limitations, some standards have been assessed against both the relevant SC Light-UAS provision(s) and the corresponding SORA requirement(s).
- The AMC & GM to Implementing Regulation (EU) 2021/664, as published by EASA in December 2022, have been considered along with the U-space regulatory requirements.

2.3 Outcome

- For every standard, a list of sections, subsections, paragraphs, or combination thereof that have been deemed suitable to show compliance with each requirement within scope and may be used as a basis of a means of compliance (MoC) is provided.
- Analogously, each section, subsection, or paragraph of the standards deemed not technically suitable to show compliance with the relevant requirements is identified, substantiating the required tailoring and/or complementing required before being proposed as a MoC.

3. Summaries of the standard assessments

3.1 ASTM F2483-18

3.1.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F2483-18. Standard Practice for Maintenance and the Development of Maintenance Manual for Light Sport Aircraft* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSO#03, SAIL I to VI

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2483-18 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.1.2 General remarks

ASTM F2483-18 was initially developed for Light Sport Aircraft only and the U.S. framework and, therefore, makes multiple specific references to this type of aircraft and the FAA as the regulator and competent authority.

It uses the term "Maintenance Manual" vs. the SORA terms "Maintenance Instructions", "Maintenance Programme" and "Maintenance Procedures Manual". It can be considered that the "Maintenance Manual" referred to in the standard contains "Maintenance Instructions" and is part of the "Maintenance Programme" or "Maintenance Procedures Manual" from SORA.

As per the preliminary high-level assessment, ASTM F2483-18 does not address:

- OSO#03 Assurance Criterion #2; and
- the new requirements of OSO#03 at Medium (M) and High (H) levels of robustness, such as the logging and record keeping of qualified / authorised personnel for the required maintenance tasks.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.1.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2483-18 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F2483-18			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSO#03	SAIL III & IV – Medium (M) Criterion #1 Assurance	5.1	Recommended as Guideline for the layout and format of the maintenance manual; the language and content should be adopted to EASA's framework and UAS relevant topics.
OSO#03	SAIL I & II – Low (L) Integrity & Criterion #1 Assurance	5.2 11.2 Annex A1	Recommended as Guideline for the development / documentation of the maintenance manual; the language and content should be adopted to EASA's framework and UAS relevant topics. The guidelines do not fully cover all relevant topics related to UAS and cover some topics specific to Light sports aircraft. Only partial coverage of the requirements.
OSO#03	SAIL III & IV – Medium (M) Integrity & Criterion #1 Assurance SAIL V & VI – High (H) Integrity Criterion #1 Assurance	5.2 11.2 Annex A1	Recommended only for the common part with Low (L) – see above

3.1.4 Non-recommended sections

This subsection provides the list of elements of ASTM F2483-18 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F2483-18			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 6.2	Typical Tasks Line Maintenance	OSO#03 SAIL I to VI Integrity & Criterion #1 Assurance	Only for the common part with Low (L) on the documentation / development of the maintenance manual. The content needs to be tailored to address UAS relevant topics and the wording needs to be adapted to make it consistent with EASA's framework.
Section 7.2	Typical Tasks Heavy Maintenance	OSO#03 SAIL I to VI Integrity & Criterion #1 Assurance	Only for the common part with Low (L) on the documentation / development of the maintenance manual. The content needs to be tailored to address UAS relevant topics and the wording needs to be adapted to make it consistent with EASA's framework.
Section 8.2	Overhaul Manual	OSO#03 SAIL I to VI Integrity & Criterion #1 Assurance	Only for the common part with Low (L) on the documentation / development of the maintenance manual. The content needs to be tailored to address UAS relevant topics and the wording needs to be adapted to make it consistent with EASA's framework.

3.2 ASTM F2908-18

3.2.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F2908-18. Standard Specification for Unmanned Aircraft Flight Manual (UFM) for Unmanned Aircraft System (UAS)* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs#08+;
- EASA SC Light-UAS – Medium & High Risk provisions:
    - SC Light-UAS.2105(b);
    - SC Light-UAS.2350(b);
    - SC Light-UAS.2380(a);
    - SC Light-UAS.2380(b);
    - SC Light-UAS.2380(c); and
    - SC Light-UAS.2620.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2908-18 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.2.2 General remarks

ASTM F2908-18 states in its introduction that it covers "light UAS"; it is considered that this is aligned with EASA's SC-Light UAS requirements (applicable up to MTOW of 600 kg). Therefore, eventual MoC derived from the recommended sections of this ASTM F2908-18 could be applied in the framework of EASA's SC-Light UAS.

According to the preliminary high level assessment, the following requirements are not covered by the standard:

- OSOs#08+ Criterion #2 Integrity;
- OSOs#08+ Criterion #3 Integrity;
- OSOs#08+ Assurance;
- Light-UAS.2350(b);
- Light-UAS.2380(a)&(c); and
- Light-UAS.2620(d)&(e).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.2.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2908-18 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F2908-18			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSOs#08+	SAIL I to VI Criterion #1 Integrity	Section 7.7	This section is recommended as guidance to identify the list of items that manufacturers should provide to the operators with respect to the normal operations of the UAS. Procedures which are not related to the operation of the UAS are not covered as they are out of scope of this standard, thus the coverage is partial.
Light-UAS.2105(b)	SAIL III to VI	Section 7.6	Applicants will need to agree with the authority on the applicability of the items marked as “Optional” by the standard. Coverage is thus considered partial as some items may not be covered.
Light-UAS.2620(a),(b),(c)&(f)	SAIL III to VI	All sections	

3.2.4 Non-recommended sections

This subsection provides the list of elements of ASTM F2908-18 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F2908-18			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 7.5	General Information and System Description	Light-UAS.2380(b) SAIL III to VI	Section 7.5 only covers Launch & Recovery Equipment (7.5.5) but no further ancillary equipment. Addressed sections can be used and are applicable. Further guidance for other types of Launch & Recovery Equipment is required. Further information is required; the recommended section only covers high-level content/topics without further details.
Section 7.6	Performance and Limitations	Light-UAS.2380(b) SAIL III to VI	Only section 7.6.21 does slightly address the requirement on a high level. Very limited applicability; no specific guidance for ancillary equipment is given in section 7.6.
Section 7.7	Normal Procedures	Light-UAS.2380(b) SAIL III to VI	Section 7.7 only covers Launch & Recovery Equipment (7.7.1.3) but no further ancillary equipment. Addressed sections can be used and are applicable. Further guidance for other types of ancillary equipment is required. Further information is required; the recommended section only covers high-level content/topics without further details.
Section 7.8	Emergency Procedures	Light-UAS.2380(b) SAIL III to VI	Only sections 7.8.1 and 7.8.2.8 slightly address the requirement on a high level but do not specifically address ancillary equipment. Very limited applicability; no specific guidance for ancillary equipment is given in section 7.8.

Section 7.11	Supplements	Light-UAS.2380(b) SAIL III to VI	Only sections 7.11.1 and 7.11.2 slightly address the requirement on a high level. Very limited applicability; no specific guidance for ancillary equipment is given in section 7.11.

3.3 ASTM F2909-19

3.3.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F2909-19. Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSO#03, SAIL I to IV;
  - OSO#07, SAIL I to VI;
  - OSOs#08+, SAIL I to VI.
- EASA SC Light-UAS – Medium & High Risk provisions:
  - Light-UAS.2240;
  - Light-UAS.2340; and
  - Light-UAS.2625.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2909-19 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.3.2 General remarks

As per the preliminary high-level assessment, ASTM F2909-19 does not address the following requirements:

- OSO#03 Assurance Criterion #2;
- OSO#07 Assurance Criterion #2;
- OSOs#08 – everything related to "human error" and "emergency response plan";
- Light-UAS.2240;
- Light-UAS.2340(b);
- Light-UAS.2340(c);
- Light-UAS.2340(d); and
- Light-UAS.2625.

ASTM F2909-19 is a useful standard, but should not be used in the current version as a standalone AMC for the assessed requirements. It does not cover:

- training of personnel for inspection and/or maintenance;
- maintenance items to be covered; and
- record-keeping of personnel qualifications and authorisations;

ASTM F2909-19:

- provides useful information for data exchange between the manufacturer and the operator for safety of flight information;
- clarifies the mechanism and criteria for the manufacturer to issue Safety Directives and Notices of corrective actions; and

- provides useful information about inspection items for Continued Airworthiness, but mainly covers pre-flight inspections items.

For section 5.3.6, the inspection items can be considered relevant for periodic UAS configuration conformity check and /or as pre-flight inspections, depending on the UAS and/or ConOps.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.3.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F2909-19 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F2909-19			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSO#03	SAIL I & II – Low (L) Integrity	Section 9	Section 9 addresses the topic of safety directives. General maintenance instructions or requirements are not addressed. The requirement is only partially covered.
OSO#03	SAIL III & IV – Medium (M) Integrity	Sections 6.1 – 6.2 and 9	Only partially covering the requirements of Logging. Section 6.1 should be complemented with guidelines on how to place the individual maintenance logs in the context of the maintenance log system. Section 9 is recommended only for the common part with Low (L) – see above.
OSO#03	SAIL V & VI – High (H) Integrity	Sections 6.1 – 6.2 and 9	Recommended only for the common part with Medium (M) – see above.
OSO#03	SAIL I & II – Low (L) Criterion #1 Assurance	Sections 6.1 – 6.2 and 9	Each of the sections partially address some of the requirements of Low Criterion #1 Assurance.
OSO#03	SAIL III to VI – Medium (M) & High (H) Criterion #1 Assurance	Sections 6.1 – 6.2 and 9	Recommended only for the common part with Low (L) – see above
OSO#07	SAIL I to VI Integrity	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of periodic UAS configuration conformity check items.

OSO#07	SAIL I to VI Criterion #1 Assurance	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of periodic UAS configuration conformity check items. The recommended sections do not cover the need for checklists or external validation.
OSOs#08+	SAIL I to VI Criterion #1 Integrity	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of pre-flight inspection items. Recommended as a guideline.
OSOs#08+	SAIL I – Low (L) Assurance	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of pre-flight inspection items. Recommended as a guideline.
OSOs#08+	SAIL II – Medium (M) Assurance	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of pre-flight inspection items. Recommended as a guideline.
Light-UAS.2340(a)	SAIL III to VI	Sections 5.3.6.1 – 5.3.6.4	The list is not exhaustive but provides a variety of pre-flight inspection items not applicable to SAIL I Assurance, as it does not require development according to a standard

3.3.4 Non-recommended sections

No elements of ASTM F2909-19 have been deemed to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof.

3.4 ASTM F3266-18

3.4.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3266-18. Standard Guide for Training for Remote Pilot In Command of Unmanned Aircraft Systems (UAS) Endorsement* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSOs#09+, SAIL I to VI; and
  - OSO#19 Criterion #2, SAIL III to VI.
- EASA's remote crew training-related requirements:
  - AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);
  - AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e); and
  - AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3266-18 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.4.2 General remarks

ASTM F3266-18 provides useful guidelines about theoretical and practical remote pilot training.

This standard does not cover the following aforementioned requirement:

- OSOs#09+ Assurance, Medium (M) & High (H);
- OSO#19 Criterion #2 Assurance, Medium (M) & High (H); and
- AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.4.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3266-18 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3266-18			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSOs#09+	SAIL I to VI Integrity	5.2 6.2 6.3 6.4	Only airspace operating principles, meteorology, navigation/charts, and UAS aspects are covered under theoretical training.
OSOs#09+	SAIL I & II Assurance	5.1 6.1	The need for theoretical and practical training is addressed.
OSO#19 Criterion #2	SAIL III to VI Integrity	6.3 6.4	Crew Resources Management (CRM) and Threat Error Management (TEM) training are addressed without providing CRM theoretical courses and related syllabus. Moreover, the training to use procedures and checklists is covered.
OSO#19 Criterion #2	SAIL III Assurance	5.1 6.1	The need for theoretical and practical training is addressed.
AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	6.2	Theoretical knowledge about UAS aerodynamics, systems and structures, airspace operating principles, navigation/charts, meteorology and accident reporting is provided.

AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	6.3 6.4	Ground and flight training are addressed but some abnormal situations, and initial and recurrent training are not addressed.

3.4.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3266-18 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3266-18			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 5.2	Knowledge / general knowledge subject matter requirements for remote crew training	OSO#19 Criterion #2 Integrity SAIL III to VI	Specifications about Crew Resource Management (CRM) shall be provided.

3.5 ASTM F3298-19

3.5.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3298-19. Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSO#02, SAIL III to VI;
  - OSO#05, SAIL III to VI;
  - OSO#13, SAIL I to VI;
  - OSO#20, SAIL II to VI;
- EASA SC Light-UAS – Medium & High Risk provisions:
  - Light-UAS.2100;
  - Light-UAS.2102;
  - Light-UAS.2105;
  - Light-UAS.2135;
  - Light-UAS.2160;
  - Light-UAS.2235;
  - Light-UAS.2240;
  - Light-UAS.2250;
  - Light-UAS.2260;
  - Light-UAS.2300;
  - Light-UAS.2305;
  - Light-UAS.2325;
  - Light-UAS.2340;
  - Light-UAS.2370;
  - Light-UAS.2375;
  - Light-UAS.2380;
  - Light-UAS.2400;
  - Light-UAS.2405;
  - Light-UAS.2410:
  - Light-UAS.2415;
  - Light-UAS.2430;
  - Light UAS.2510;
  - Light-UAS.2530;
  - Light-UAS.2605;
  - Light-UAS.2610; and
  - Light-UAS.2615.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3298-19 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.5.2 General remarks

Whilst ASTM F3298-19 states in its introduction that it covers "*lightweight (UAS) (not necessarily limited to UA under 55 lb MTOW)*", it is considered that the UA weight is not a limiting factor and a MoC referring to the ASTM F3298-19 recommended sections could be applied to UA with a MTOM of up to 600 kg in an analogous manner as EASA's SC-Light UAS requirements.

In accordance with the preliminary high-level assessment, the following requirements are not covered by this standard:

- OSO#02;
- OSO#05 Assurance;
- OSO#13;
- Light-UAS.2105(b);
- Light-UAS.2105(d);
- Light-UAS.2105(e);
- Light-UAS.2260; and
- Light-UAS.2305.

Most of each of the recommended sections do not fully cover the entire requirements but, when gathered, provide a better (in most cases, not total) coverage.

On the other hand, some non-recommended sections, once tailored as proposed, have the potential to be proposed as a MoC.

Whilst there is a good correlation between SORA v2.5 OSO#5 and EASA SC Light-UAS.2510 requirements, they have been assessed independently leading to few differences in the results.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.5.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3298-19 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3298-19			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSO#05	Integrity SAIL III	5.6.2 7.9.2.7 7.10.1.2(5) 16.3 A2.3	
OSO#05	Integrity SAIL IV	5.6.2 7.9.2.7 7.10.1.2(5) 16.3 A2.3	
OSO#05	Integrity SAIL V & VI	5.6.2 7.9.2.7 7.10.1.2(5) 10.1.3 10.6.3 11.1.3 16.3 A2.3	

Light-UAS.2100	SAIL III to VI	5.2 13.2 14.2.5 16.2.2	These sections provide useful guidance for showing compliance with Light-UAS.2100 requirements, but do not address them completely. The mass configuration is defined with some details but may not be complete in its considerations. A definition of repeatable condition or how this is ensured are not addressed. Section 16.2.2 focuses on fuel-propelled UAS; therefore, it should be completed with relevant guidance for UAS with an electric propulsion system. Add-on safety equipment, such as parachutes, should also be considered.
Light-UAS.2102	SAIL III	5.6.2 9.6	These sections provide some tools and guidelines for defining the flight envelope limits, but they do not cover the requirement completely. They provide no guidance on how to address the definition of the environmental and adverse weather limits. Section 9.6 provides guidelines for UA without envelope protection, which does not exist in SORA for SAIL III, due to OSO#018; hence, these subsections should be ignored.
Light-UAS.2102	SAIL IV to VI	5.1 5.6.2 9.6	These sections provide some tools and guidelines for defining the flight envelope limits, but they do not cover the requirement completely. They provide no guidance on how to address the definition of the environmental and adverse weather limits. Section 9.6 provides guidelines for UA without envelope protection, which does not exist in SORA for SAIL IV and higher, due to OSO#018; hence, these subsections should be ignored.

Light-UAS.2105(a)&(c)	SAIL III to VI	5.1 5.4 5.6.1 6.1 – 6.5 6.6.2 – 6.6.6	The recommended sections only partially address Light-UAS.2105(a)&(c) since they only cover specific configurations and not all elements to demonstrate safe operations within the operational envelope. The following minor adaptations are proposed: – the standard should also include the rate of descent, max hover altitude, approach speed, and external load performances as required by Light-UAS.2105; – Sections 5.1, 6.1 - 6.5, and 6.6.2 - 6.6.6 should indicate the need to demonstrate the performance in still air and standard atmospheric conditions at sea level; – Sections 6.6.2 - 6.6.6 should include guidance on how to define performance in hovering flight conditions.
Light-UAS.2135	SAIL III & IV	5.6.1, except for 5.6.1.5 6.5 6.6.5 7.10.1 16.1.2	Many of these sections are configuration-dependent and, thus, not implementation-agnostic. With the combination of the sections referenced here, the requirements of Light-UAS.2135 are fully addressed. The rotor low speed warning system (5.6.1.5) is excessive for Medium risk; it should not be applied.
Light-UAS.2135	SAIL V & VI	5.6.1 6.5 6.6.5 7.10.1 16.1.2	Many of these sections are configuration-dependent and, thus, not implementation agnostic. The requirements of Light-UAS.2135 are not fully addressed. Clear criteria to fulfil the flight test compliance method is not provided.
Light-UAS.2160	SAIL III to VI	9.7.1 16.1.3 16.9.1	Only Section 16.1.3 completely addresses the requirement by giving recommendations for flight testing for buffeting and vibration. However, it does not provide the manoeuvres or specific implementation of the flight tests

			to show compliance. Also, it does not specify how observation during flight tests should be implemented. Sections 9.7.1 and 16.9.1 provide some useful guidance on the design of rotor systems for rotorcraft and vertical lift aircraft.
Light-UAS.2235	SAIL III & IV	7.8.1 7.8.2 7.10.5 7.11.3 7.12.1 7.12.4(1)&(2) 9.1 9.2.2 9.2.3 9.2.4 9.3.2 9.3.3 9.4 16.2.1 16.2.3	Sections 7.8.2 and 7.10.5 are not very helpful for showing compliance, but they consider control surface loads. Sections 9.2.2, 9.2.4, 9.3.2 and 9.3.3 should be considered as additional information to 9.1 The recommended sections provide guidance on safety factors, load assumptions, and strength requirements for components (e.g. propeller, gear, controls, airframe). Overall, they cover all strength requirements but do not address the environmental conditions as required by Light-UAS.2235(c).
Light-UAS.2235	SAIL V & VI	7.8.1 7.8.2 7.10.5 7.11.3 7.12.1 7.12.4(1)&(2) 9.1 9.2.2 9.2.3 9.2.4 9.3.2	Sections 7.8.2 and 7.10.5 are not very helpful for showing compliance, but they consider control surface loads. Sections 9.2.2, 9.2.4, 9.3.2 and 9.3.3 should be considered as additional information to 9.1 The recommended sections provide guidance on safety factors, load assumptions, and strength requirements for components (e.g. propeller, gear, controls, airframe). Overall, they cover all strength requirements but do not

		9.3.3 9.4 9.5.1 9.5.2 9.5.4 9.5.5 9.5.6 16.2.1 16.2.3 16.8.2	address the environmental conditions as required by Light-UAS.2235(c).
Light-UAS.2240	SAIL III to VI	8.2 8.3	Sections 8.2 & 8.3 cover the aspects of fasteners and accessibility as aspects of design for structural monitoring. However, they do not address procedures, inspections or continued airworthiness.
Light-UAS.2250	SAIL III & IV	7.4 7.5 7.11.3 7.12.1 7.12.3 7.12.4 7.12.5 8.2 16.9.1	Design principles cover safe design considerations, safety factors, failure conditions. Structures, installations, propeller, fastener, access, risk reduction (on ground). Design data as required in Light-UAS.2250(b) is not addressed. Operating conditions are only partially addressed.
Light-UAS.2250	SAIL V & VI	7.2 7.5 7.11.3 7.12.1 7.12.3 7.12.4 7.12.5 8.2	Design principles cover safe design considerations, safety factors, failure conditions. Structures, installations, propeller, fastener, access, risk reduction (on ground). Design data as required in Light-UAS.2250(b) is not addressed. Operating conditions are only partially addressed.

		16.9.1 A2.2.1	
Light-UAS.2300	SAIL III to VI	7.10.1 7.11.2 10.3 10.5 16.1.2 16.2.4 16.5.2.1 X8.1 X8.2	The recommended sections cover general considerations for flight control design, envelope protections, CU indications, stability/control, mechanical requirements, C2 link, actuating forces. The following restrictions apply: – Section 7.11.2 may only be applicable to certain UAS design configurations (e.g., fixed-wing) – Sections X8.1 & X8.2: the formulae provided may not fit all UAS designs or UAS design approaches. Further assessment by the designer would be needed. Aspects of software assurance or reliability of implemented functions are not included in ASTM F3298-19.
Light-UAS.2325	SAIL III to VI	7.1 A2.4.4	The information contained in these two sections may not be sufficient for fire protection design as they are too high level. Specific information on design criteria is missing.
Light-UAS.2340	SAIL III to VI	5.6.1 6.1 6.2 6.3 6.4 6.5 6.6.2 6.6.3 6.6.4 6.6.5 6.6.6 7.6 7.10.2	The recommended sections cover limitations for rotor speed and pitch, speeds, take-off and landing distances, climb performance, engine failure, autorotation, payloads, propulsion system and power setting. Limitations are considered for conventional and VTOL configurations separately. They give criteria on how to present the limitations to the operator and what limitations to present. Normal and Emergency procedure as well as ground check and maintenance requirements and examples are provided. However only part of these procedures can be

		12.1 13.3 14.2.4 14.2.5 14.2.7 14.3	recommended as they are high level and seem not complete/partly not suitable. Limitations from environmental conditions are not further addressed.
Light-UAS.2370	SAIL III to VI	7.10.2	Section 7.10.2 only addresses part of Light-UAS.2370(b). It does not provide aspects to ensure transportation and storage in design or instructions.
Light-UAS.2375(a)	SAIL III to VI	7.2 12.1.3 12.1.4 16.7.1	Section 7.2 provides general requirements for installations. Sections 12.1.3 & 12.1.4 provide useful recommendations for payload attachments and installations. Section 16.7.1 requires demonstration to ensure safe operation of installed payloads. Point 2) of Light-UAS.2375(a) on dangerous goods is not addressed.
Light-UAS.2375(b)	SAIL III to VI	7.2 10.4.3 12.1 16.7	Subsections 7.2.1.2(2)&(3) address the requirement. Other sections focus on design aspects and proper functioning. Section 10.4.3 addresses the requirement regarding payload data link specifics. Other subsections do not address the requirement. Section 12.1 provides useful recommendations for the establishment of payload limitations.

			Section 16.7.1 requires demonstrations which might be useful for procedures and instructions. HIRF limitations shall be considered as per Section 16.7.2.
Light-UAS.2380(a)	SAIL III to VI	11	Section 11 only covers Launch and Recovery Equipment and Tether systems.
Light-UAS.2380(b)	SAIL III to VI	11.1	Section 11.1 only covers Launch and Recovery Equipment and Tether systems.
Light-UAS.2380(c)	SAIL III to VI	11	Section 11 only covers Launch and Recovery Equipment and Tether systems.
Light-UAS.2400	SAIL III & IV	7.9.3 7.9.4 7.9.6 7.12.3 7.12.4 7.12.5 7.12.6 9.7.1 16.3	These sections provide specific requirements and guidance to address LIght-UAS.2400 for different subsystems and components of the Lift/Thrust/Power system. The actual combination of sections will depend on the specific UAS design / configuration.
Light-UAS.2405	SAIL III to VI	6.5 7.11.3 7.12.6 16.3	
Light-UAS.2410	SAIL III to VI	7.12.6 15.1 15.2 15.4 15.5 16.3	For Section 7.12.6, EASA would need to confirm that 100 h of flight that is representative of operational use, without significant problems, is acceptable evidence of compatibility of the powerplant and rotor combination.

		16.4 16.9.1	
Light-UAS.2415	SAIL III to VI	5.4 5.5 5.6	These sections only address Light-UAS.2415(c), not covering the last item on maximum permitted duration for ratings.
Light-UAS.2415	SAIL III to VI	7.11.3	Section 7.11.3 is focused on the propeller only.
Light-UAS 2415(a)&(b)	SAIL III to VI	16.3	Section 16.3 focuses on the propulsion system.
Light-UAS.2430	SAIL III to VI	10.5.7	Section 10.5.7 provides useful recommendations to show compliance with Light.UAS.2430(b).
Light-UAS.2510	SAIL III to VI	5.6.2	
Light-UAS.2510(a)(1)	SAIL III & IV	7.9.2.7 7.10.1.2 16.3 A2.3	These sections provide specific interpretation of hazards minimisation that could be quoted in a MoC with Light-UAS.2510(a)(1), but they do not address the rest of the provision.
Light-UAS.2510	SAIL V & VI	7.9.2.7 7.10.1.2 10.1.3 10.6.3 11.1.3 16.3 A2.3	These sections are good design means /practices that have a direct impact on the severity classification but there may be other means. So it is important to state as a preamble that this is one possible design means to handle the system failures but there may be alternative means
Light-UAS.2530	SAIL III to VI	7.10.3 7.10.4 16.5.4 A.2.4.2 A.2.4.3 A.2.4.4	Light-UAS.2530(d) is not covered. Light-UAS.2530(e) is partially covered; taxi lights are not addressed.

Light-UAS.2605	SAIL III to VI	5.6.1 7.6 7.9.6 7.10.1.2 7.10.5.3 7.11.4 10.2.1 10.2.5.3 10.2.5.4 10.2.6.2 10.3.1(3) 10.3.2 10.5.7 10.5.8 10.6.3 16.5.1 16.5.2.1 16.5.2.2 A2.4.1.1 A2.4.1.2 A2.4.1.4 A2.4.1.5	These sections provide good information on what should be displayed on the Command Unit (CU) but neither fully cover all the information that may need to be displayed nor address all points of the requirement.
Light-UAS.2610(a)&(b)	SAIL III to VI	10.5.8	
Light-UAS.2615	SAIL III to VI	7.6 7.9.6(3) 7.11.4 10.2 10.3.2 10.5.7 10.6.3 16.5.1 16.5.2.2	Sections 7.9.6.3, 10.2, and 10.3.2 only address Light-UAS.2615(a).

		A2.4	

3.5.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3298-19 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3298-19			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
7.2.2	Single failure handling	OSO#05 SAIL III Integrity	Section 7.2.2.2 goes much beyond the OSO#05 "minimal" safety requirement for a Low Integrity Criteria
		OSO#05 SAIL IV Integrity	Same as above and it does not address the additional requirement for Medium Level of Integrity.
		OSO#05 SAIL V & VI Integrity	Although it provides three ways to cope with single failure that may be useful in performing the detailed Safety Assessment required for High Integrity, it would be necessary to review the link with the probability/severity relationship as envisaged by OSO#05.
10.1.3	General/Loss of UA control due to Control station	OSO#05 SAIL III Integrity	Section 10.1.3 goes much beyond the "minimal" the OSO #05 Low level integrity criteria.
		OSO#05 SAIL IV Integrity	Same as above Criteria and it does not address the additional requirement for Medium Level of Integrity
10.6.3	Lost Link	OSO#05 SAIL III Integrity	In case the lost link would be "probable" (thus greater than Extremely Remote), this section provides a way to cope with it and define procedures and design requirements. However, in case of UAS operations in an airspace risk class ARC-a (while GRC=4), SAIL could be III; in this latter case, 10.6.3.2(5)

			and 10.6.3(3) dealing with ATC communications would not be applicable.
		OSO#05 SAIL IV Integrity	Same as above. Medium Level of Integrity may be required (SAIL IV) in case GRC=5 and ARC-a ; in such a case, however, 10.6.3.2(5) and 10.6.3(3) dealing with ATC communications would not be applicable.
11.1.3	Other Required Off-Board Subsystems	OSO#05 SAIL III Integrity	Section 11.1.3 goes much beyond the "minimal" the OSO #05 Low level integrity criteria
		OSO#05 SAIL IV Integrity	Same as above and it does not address the additional requirements for Medium Level of Integrity
16.5.2.1	Teleoperated Flight systems	OSO#20 SAIL II to VI Integrity	Section 16.5.2.1 should cover how an HMI analysis should be performed. Furthermore, Section 16.5.2.1 should address guidelines/best practices to prevent fatigue and confusion in the design of the HMI, as well as guidelines/best practices on how to lay out the HMI for clarity.
		OSO#20 SAIL IV to VI Assurance	
5.1	Proof of compliance	Light-UAS.2102 SAIL III – Medium (M)	Although Section 5.1 provides additional details on the definition of the upper flight speeds that create the upper boundary of the flight envelope, the requirements proposed are excessive for UAS intended to be used in a SAIL III operation.
6.1	Fixed-wing UA performance	Light-UAS.2102 SAIL III to VI – Medium (M) & High (H)	Although Section 6.1 provides useful guidance to identify stall speeds for fixed-wing UA not featuring envelope protection, UAS to be operated in SAIL III and higher are required to have envelope protection.
7.8.3	Stability	Light-UAS.2135	The standard requires static stability, while Light-UAS.2135 explicitly allows for artificial means to achieve stability.

		SAIL III to VI – Medium (M) & High (H)	
7.11.1	Loads and Dynamics	Light-UAS.2135 SAIL III to VI – Medium (M) & High (H)	The standard should also allow for the possibility in which the UA design prevents (i.e., makes it improbable) asymmetric control surface deployment. The fail-safe design of the asymmetric control surface deployment is just another possibility.
9.5.1 9.5.2 9.5.4 9.5.5 9.5.6 16.8.2	Symmetrical wing loads Gust load factors Rolling conditions Yawing conditions Control surface loads Airframe	Light-UAS.2235 SAIL III & IV – Medium (M)	The complete computation of the different loads is disproportionate for medium risk operations.
7.2	Equipment, Systems, and Installation	Light-UAS.2250 SAIL III & IV – Medium (M)	The failure conditions in subsection 7.2.2 are disproportionate for Medium risk operations.
A2.2.1	Design of UAS intended to be operated over people or in airspace where it may encounter other aircraft	Light-UAS.2250 SAIL III & IV – Medium (M)	The design criteria provided is excessive for Medium risk operations.
7.3	Materials and Workmanship	Light-UAS.2260 SAIL V & VI – High (H)	The standard mentions the need to have manufacturing procedures that cover e.g. the specification of materials, but these procedures should be further detailed in order to address the requirement.
7.10.5	Landing Gear	Light-UAS.2305 SAIL III to VI – Medium (M) & High (H)	While Section 7.10.5 adds a new requirement, it does not provide guidance on how to comply with Light-UAS.2305.
14.2.8	Normal procedures and checklists	Light-UAS.2340	Section 14.2.8 addresses checklists implementation at a very high level.

		SAIL III to VI – Medium (M) & High (H)	
X9.1	Ground check	Light-UAS.2340 SAIL III to VI – Medium (M) & High (H)	Section X9.1 addresses ground checks, but at a high level and not covering all (essential) aspects of UAS operations.
7.1	General	Light-UAS.2375(a) SAIL III to VI – Medium (M) & High (H)	Section 7.1 only addresses general design aspects but not specific provisions for payload installation / accommodation.
7.1	General	Light-UAS.2375(b) SAIL III to VI – Medium (M) & High (H)	Section 7.1 only addresses general design aspects but not limitations, procedures or instructions.
7.9.1	Propulsion system – Installation	Light-UAS.2400 SAIL III to VI – Medium (M) & High (H)	Section 7.9.1 provides only general installation requirements; more information and substantiation is needed to be used as MoC for Light-UAS.2400
7.9.3 7.9.4 7.9.6 7.12.3 7.12.4 7.12.5 7.12.6 9.7.1 16.3	Electric Propulsion Unit (EPU) wiring Fuel and oil system Propuls instruments Engine torque Vertical lift propellers Rotor spin up & brake Compatibility Rotor system Propulsion system	Light-UAS.2400 SAIL V & VI – High (H)	More substantiation is required to be used as a MoC for high-risk operations.
16.3	Best practices – Propulsion system	Light-UAS.2415 SAIL III to VI – Medium (M) & High (H)	Section 16.3 needs to be complemented in order to more specifically address the Note to SC-Light-UAS.2415
7.9.5	Energy Storage Devices	Light-UAS.2430	Although it may be used as design recommendations, except for the reference to F3005, the term ‘safety critical’ is not

		SAIL III to VI – Medium (M) & High (H)	clearly defined and should be related to the EASA failure severity classification before this section can be used as a MoC.
10.6.3	Lost Link	Light-UAS.2510 SAIL III & IV – Medium (M)	In case the lost link would be "probable" (thus greater than Extremely Remote), this section provides a way to cope with it and define procedures and design requirements. In case UAS operations take place in an airspace risk class ARC-a, while GRC-4 or GRC-5, SAIL could be III or IV; in this latter case, 10.6.3.2(5) and 10.6.3 (3) dealing with ATC communications would not be applicable.
7.2.2.2	Installation – single failures	Light-UAS.2510 SAIL V & VI – High (H)	Section 7.2.2.2 provides three ways to cope with single failure that may be useful in performing the detailed Safety Assessment required for High Risk in the framework of a MoC. However, SC Light-UAS.2510(a)(1) excludes the account of probability for single failure (if Catastrophic) and point (1) of Section 7.2.2.2 does allow that single failure leading to loss of Control to be Extremely Remote
7.10.1.2(5)	Automatic Flight Control System	Light-UAS.2510 SAIL V & VI – High (H)	Point (5) of Section 7.10.1.2 should support the more detailed safety assessment of the system failure conditions required for High Risk. It would be, however, necessary to review the link with the probability/ severity relationship as envisaged by the Note / OSO#5 risk criteria.
10.1.3	General/Loss of UA control due to Control station	Light-UAS.2510 SAIL V & VI – High (H)	Section 7.2.2.2 provides three ways to cope with single failure that may be useful in performing the detailed Safety Assessment required for High Risk in the framework of a MoC. However, SC Light-UAS.2510(a)(1) excludes the account of probability for single failure (if Catastrophic) and point (1) of Section 7.2.2.2 does allow that single failure leading to loss of Control to be Extremely Remote. Also, it would be

			necessary to review the link with the probability/ severity relationship as envisaged by the Note / OSO#5 risk criteria.

3.6 ASTM F3309/F3309M-21

3.6.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3309/F3309M-21. Standard Practice for Simplified Safety Assessment pof Systems and Equipment in Small Aircraft* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA Annex D TMPR requirements;
- SORA v2.5 OSO#05, SAIL III to VI;
- SORA Annex E v2.5 section 4 requirements for the containment of the operation (Step #8);
- EASA SC Light-UAS – Medium & High Risk provisions:
    - Light-UAS.2400(c);
    - Light-UAS.2510;
    - Light-UAS.2511(a);
    - Light-UAS.2511(b)(1)&(2).

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3309/F3309M-21 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.6.2 General remarks

ASTM F3309/F3309M-21, as indicated in its title, aims at providing a simplified way to perform system safety assessment for "small" aircraft.

Detailed technical assessment has been performed for SORA v2.5 OSO#5 and EASA SC Light-UAS.2510 only, for the reasons stated below:

- SORA Annex D TMPR integrity requirements do not provide specific criteria on how to make the safety assessment;

- Light-UAS.2400(c): showing compliance with Light-UAS.2510 directly supports demonstration of compliance with Light-UAS.2400(c) since Light-UAS.2400(c) refers to Light-UAS.2510: "*The hazards in the event of a malfunction or failure of the Lift/Thrust/Power Control Systems and the Lift/Thrust/Power System Installation need to be assessed and mitigated in accordance with the airworthiness standards Light-UAS.2500 and Light-UAS.2510.*"

- Light-UAS.2511, as well as parallel SORA v2.5 Step#8 Criterion #1 – Low (L), Medium (M) & High (H) and Criterion #4 – Medium (M) & High (H), require to perform safety analyses and/or design & installation appraisal, as required by OSO#5 and Light-UAS.2510. See below comparison table:

Requirement (Light-UAS.2511 & SORA v2.5 Step#8)	Compliance method	OSO#05 Assurance criterion for comparison

SAIL III to VI SC Light-UAS.2511(a): *No probable failure of the UAS or of any external system supporting the operation must lead to operation outside the operational volume*.	Note (Part 1): *Compliance with the airworthiness standard referred to in point (a) should be substantiated by a design and installation appraisal and should include at least:* *– The design and installation features (independence, separation and redundancy);* *– Any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference, etc.) associated with the operation*.	SAIL III to VI *A Functional Hazard Assessment and a design and installation appraisal that shows hazards are minimised are available.* *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*.
SAIL III to VI SC Light-UAS.2511(b)(1): *When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer, the probability of leaving the operational volume must be demonstrated to be acceptable with respect to the risk posed by a loss of containment*. SAIL III to VI SC Light-UAS.2511(b)(2): *When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer, no single failure of the UAS or of any external system supporting the operation must lead to its operation outside the ground risk buffer*	Note (Part 1): *Compliance with the airworthiness standard referred to in points (b)(1)&(2) should be substantiated by analysis and/or test data with supporting evidence*.	SAIL III to VI See above
SORA Step #8 Criterion #1 (Low & Medium) (Qualitative) *No probable failure of the UAS or any external system supporting the operation shall lead to*	*Compliance is to be substantiated by a design and installation appraisal and includes as a minimum:*	SAIL III to VI See above

operation outside of the operation volume. OR (Quantitative) *The probability of the failure condition "UA leaving the operational volume" considering all failure modes of interest shall be less than 10-3/Flight Hour (FH)*.	*– design and installation features (independence, separation and redundancy);* *– any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the operation*.	
SORA Step #8 Criterion #1 (High) (Qualitative) *No remote failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume*. OR (Quantitative) *The probability of the failure condition "UA leaving the operational volume" considering all failure modes of interest shall be less than 10-4/FH*.	*Compliance is to be substantiated by a design and installation appraisal and includes as a minimum:* *– design and installation features (independence, separation and redundancy);* *– any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the operation*.	SAIL III to VI See above
SORA Step #8 Criterion #4 (Medium & High) *No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer*.	Not specified	SAIL III to VI See above

Therefore, it was determined there was no need to perform a detailed technical assessment and conclusions regarding the suitability of ASTM F3309/F3309M-21 reached for OSO#5 and Light-UAS.2510 could be directly used for conclusion regarding the suitability of ASTM F3309/F3309M-21 for Light-UAS.2400(c), Light-UAS.2511(a)&(b)(1)&(b)(2), and SORA v2.5 Step#8 Criterion #1 – Low (L), Medium (M) & High (H) and Criterion #4 - High (H).

Additionally, considering that ASTM F3309/F3309M-21 is oriented to Level 1 and Level 2 manned aircraft (as defined in FAR 23/CS23), most of the sections could not be recommended "as is" since, in most of the cases, they need to be tailored and adapted to suit specific UAS characters. However, once duly tailored, they could be used as MoC to above quoted requirements to perform the required safety analysis.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.6.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3309/F3309M-21 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3309/F3309M-21			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSO#05	SAIL III to VI Assurance	Section 3.2	Useful definitions
		Section 4.4.1	Design appraisal (may well complement ED-280 – see related assessment)
		Section 4.4.2	Installation appraisal (may well complement ED-280 – see related assessment)
		Section 4.6	Common Mode Failures analysis, when credit is taken for the independence between failures
Light-UAS.2510(a)	SAIL III to VI	Section 3.2	Useful definitions
		Section 4.6	Common Mode Failures analysis, when credit is taken for the independence between failures, namely for single failure criteria of sub-requirements (a)(2) – Medium and (a)(3) – High.
Light-UAS.2511(a)&(b)(1) &(b)(2) and Note	SAIL III to VI	Section 3.2	Useful definitions
		Section 4.4.1	Design appraisal (may well complement ED-280 – see related assessment)

		Section 4.4.2	Installation appraisal (may well complement ED-280 – see related assessment)
		Section 4.6	Common Mode Failures analysis, when credit is taken for the independence between failures, namely for sub-requirement (b)(2)
SORA v2.5 Annex E Step#8	Assurance Criterion #1 – L/M/H Integrity Criterion #4 – M/H	Section 3.2	Useful definitions
		Section 4.4.1 for Assurance Criterion #1 – L/M/H	Design appraisal (may well complement ED-280 – see related assessment)
		Section 4.4.2 for Assurance Criterion #1 – L/M/H	Installation appraisal (may well complement ED-280 – see related assessment)
		Section 4.6 for Integrity Criterion #4 – M/H	Common Mode Failures analysis, when credit is taken for the independence between failures

3.6.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3309/F3309M-21 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3309/F3309M-21			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 4.1 and Figure 1	Simplified Safety Assessment Process	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	This figure provides a flowchart regarding the extent and nature of analysis to be performed as a function of manned aircraft Level (CS 23) and of failure classification, referring to subsequent sections. Whilst this concept of flow chart may be useful by providing the type of analysis as a function of failure classification but also as a function of manned aircraft Level (1 or 2,) it cannot be exactly used as is in the context of UAS and would have to be tailored (e.g. Level could be depending on the UAS configuration and/or SAIL).
Section 4.2	Failure Condition Identification and Classification	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	Failure conditions classification and definitions in Table 1 which is applicable to manned aircraft are quite different from currently agreed UAS failure severity definitions. See in ED-279 UAS failure severity definitions (derived from JARUS AMC.1309) recommended by Shepherd for FHA. SC Light-UAS.2510(a)(3) is not addressed
Section 4.4	Design & Installation Appraisal	Light-UAS.2510(a) SAIL III to VI	This requirement does not directly relate to Design or Installation appraisal which can nevertheless be based upon the results of FHA, as stated. See also comments relating to Figure 1. If this Figure 1 can be tailored to UAS applications and Design & Installation appraisal can be chosen

			as an acceptable method instead of a detailed safety assessment, then this section could become useful.
Section 4.5.1	Qualitative Analysis of Failure Conditions	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	See comments above under section 4.1 and subsequent sections. Note: Being this section devoted to qualitative analysis, the tailoring of the Flow Chart Figure 1 may also have to address the criteria to perform a quantitative analysis and not only a qualitative analysis.
Sections 4.5.2 – 4.5.4	Substantiation of Major, Hazardous and Catastrophic Failure Conditions	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	See comments above under 4.1. Once tailoring of the Flow chart is achieved (replacing Aircraft Level with e.g. UAS configuration and/or SAIL) this section requirements may be viewed as an acceptable method of substantiating Major, Hazardous and Catastrophic UAS Failure conditions.
Section 4.7	Use of similarity	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	Refer to the comments under 4.5.1 and 4.5.2 (to be tailored). Principles provided in this section for the use of similarity argument may be adapted to UAS, being understood that reference to F3061/3061M (applicable to Level 1, 2, 3, 4 manned aircraft as per CS23) may not be appropriate and may also have to be tailored
Section 4.8	Documentation	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	This section refers to 4.1. to 4.7 (except 4.4. and 4.6), which have not been recommended due to required tailoring. It is thus not recommended. However, the need for documentation will have similarly to be retained once these are duly tailored to UAS.

Section 5	Checklist	SORA v2.5 OSO#05 SORA v2.5 Annex E Step#8 Light-UAS.2510(a) Light-UAS.2400(c) Light-UAS.2511(a)&(b)(1)&(b)(2) SAIL III to VI	This section refers to table 3, which itself refers to sections that have been advised to be tailored (namely 4.2, 4.5, 4.8). It is thus not recommended. However, a similar checklist may be also proposed once these are duly tailored to UAS.

3.7 ASTM F3322-18

3.7.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3322-18. Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 mitigation means M2 – High (H) level of robustness

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3322-18 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.7.2 General remarks

ASTM F3322-18 addresses two main subjects:

1. Design of Canopy; and
2. Standardized Testing of Parachute System & Deployment

There are key points that the current version of F3322-18 is missing when comparing the standard against the requirements contained in mitigation M2:

- Definition of energy thresholds at which fatalities will / will-not occur;
- Definition of reliability of the trigger mechanism (i.e., under what conditions the parachute should deploy, which the allowable rate of false positive deployments is, etc.)
- Definition of reliability of the deployment (i.e., when the parachute is triggered, how reliable the deployment is and correct functioning)
- Detailed procedures for installation, maintenance and deployment of the parachute (Criterion #2)
    - F3322-18 covers some specific procedures relating to installation and maintenance of the parachute system. However, general installation procedures are not covered.
    - F3322-18 delineates that the parachute manual must provide guidelines regarding installation and maintenance procedures; however, it does not elaborate further on the specific details of these procedures inside the parachute manual.
- Key training topics of personnel responsible for the installation, maintenance and deployment of the measures proposed. (Criterion #3)

As a whole, F3322-18 is considered a useful standard to follow for the design and especially the testing of parachute systems. Furthermore, it is known that the standard is already being used by the industry and is working.

However, without the five major points addressed above, the standard cannot be used on its own to show compliance with the M2 requirements at a High (H) level of robustness.

An EASA MoC for a High (H) level of Integrity, similar to the MoC on M2 – Medium (M) level of Integrity that is under public consultation at the time of this assessment, should be developed to address the three first points above. In presence of such an MoC, the sections of F3322-18

recommended below may be used as an AMC for the design and testing of the canopy (not, however, for the triggering mechanism, installation procedures, and/or training).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.7.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3322-18 that may be used as a basis for a MoC for the design of a parachute system as identified in the detailed technical assessment, which can be accessed here.

ASTM F3322-18			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
M2 Criterion #1 Integrity	High / High+	5.1.1.1 5.1.4 5.4.1 5.4.3 5.7.3.1 5.7.3.2 5.8.1 5.8.3 5.8.4 5.8.4.1 5.8.5 6.4.4 6.5.5 6.6.2 6.6.3.1	Each of the listed sections only partially cover the requirements for High/High+ Integrity and the combination does not fully address the requirements. ● Whenever a requirement refers to the Automatic Triggering System (ATS), it should be considered that the M2 requirement only prescribes automatic deployment “when applicable” ● Section 6.4.4 – It should be possible that the analysis can be done by the manufacturer/ integrator and not only by external authorised partners ● Assurance of the recommended sections is only recommended under the assumption that an independent 3rd party validates the integrity in accordance with these sections
M2 Criterion #1 Assurance	High	6.2.7 6.2.8 6.3.1.1 6.4.1.2 6.4.2.1 – 6.4.2.10 6.4.4	While each of the listed sections only partially cover the requirements for High Assurance, the combination provides full coverage of the requirements. ● Whenever a requirement refers to the Automatic Triggering System (ATS), it should be considered

		6.5.2 6.5.3 6.5.4 6.6.1 6.6.3	that the M2 requirement only prescribes automatic deployment “when applicable” ● 6.4.2.1 – The list appears to be complete but might miss or prescribe certain tests to unconventional airframes where some of the tests might not be applicable. A statement that this list serves as a guidance should be included ● Section 6.4.4 – It should be possible that the analysis can be done by the manufacturer/ integrator and not only by external authorised partners ● Assurance of the recommended sections is only recommended under the assumption that an independent 3rd party validates the integrity in accordance with these sections
M2 Criterion #2 Integrity	High	5.2.1 5.9.2.1 5.9.2.2 5.9.3.1 5.9.3.3 6.2.5 6.4.3 6.6.3 6.6.3.1	Each of the listed sections only partially cover the requirements for High Integrity and the combination does not fully address the requirements. ● Section 5.2.1 – a process & training are missing on how to authorise a third-party packer.
M2 Criterion #2 Assurance	High	6.3.1.1	

3.7.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3322-18 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3322-18			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 5.4.2	Main Canopy Rate of Descent (at sea level)	M2 Criterion #1 Integrity	A consensus on Drag Coefficients for parachutes is required. Furthermore, the velocity should be a function of the remaining energy. Energy thresholds need to be established.
Section 5.5.2	Filling Distance	M2 Criterion #1 Integrity	Consensus about filling constant is required for High level of robustness
Section 5.9.3.2	Repacking	M2 Criterion #2 Integrity	A qualified operator (authorised packer according to section 5.2.1) should be able and allowed to pack the parachute.
Section 6.4.1.5	Testing Requirements	M2 Criterion #1 Assurance	The “2 second” requirement is too prescriptive and may not represent realistic conditions. Some systems could be deployed faster and others slower. This should be reflected.

3.8 ASTM F3330-18

3.8.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3330-18. Standard Specification for Training and the Development of Training Manuals for the UAS Operator* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSOs#09+, SAIL I to VI; and
  - OSO#19 Criterion #2, SAIL III to VI.
- EASA's remote crew training-related requirements:
  - AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);
  - AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e); and
  - AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3330-18 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.8.2 General remarks

ASTM F3330-18 provides guidelines on how to develop a Training Manual as regards a possible structure and outline of sections/subsections and format. It is not intended to provide guidance on the content of the training syllabi (theoretical and practical training) covered in ASTM F3266-18 and ASTM F3379-20. This standard may be adopted as Guidance Material (GM) for developing a Training Manual.

As per the preliminary high-level assessment, this standard does not address the following requirements:

- OSOs#09+ Integrity;
- OSO#19 Criterion #2 Integrity;
- AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);
- AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e); and
- AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.8.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3330-18 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3330-18			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSOs#09+	I & II Assurance	4 5 6.1 – 6.10 6.13 – 6.14	The structure and layout of the Training Manual are addressed.
OSOs#09+	III to VI Assurance	4 5 6.1 – 6.10 6.12 – 6.14	The structure and layout of the Training Manual are addressed. Moreover, section 6.12 addresses the quality assurance system.
OSO#19 Criterion #2	III Assurance	4 5 6.1 – 6.10 6.13 – 6.14	The structure and layout of the Training Manual are addressed.
OSO#19 Criterion #2	IV to VI Assurance	4 5 6.1 – 6.10 6.12 – 6.14	The structure and layout of the Training Manual are addressed. Moreover, section 6.12 addresses the quality assurance system.

3.8.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3330-18 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3330-18			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 6.12	Quality assurance	OSOs#09+ Assurance SAIL I & II	A complete quality assurance system is disproportionate for SAIL I & II.
Section 6.12	Quality assurance	OSO#19 Criterion #2 Assurance SAIL I & II	A complete quality assurance system is disproportionate for SAIL I & II.

3.9 ASTM F3366-19

3.9.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3366-19. Standard Specification for General Maintenance Manual (GMM) for a small Unmanned Aircraft System (sUAS)* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSO#03, SAIL I to VI;
- EASA SC Light-UAS – Medium & High Risk provisions:
    - Light-UAS.2240;
    - Light-UAS.2340(b);
    - Light-UAS.2340(c);
    - Light-UAS.2340(d);
    - Light-UAS.2370(c); and
    - Light-UAS.2625.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3366-19 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.9.2 General remarks

As per the preliminary high-level assessment, the following requirements are not covered by ASTM F3366-19:

- SORA v2.5 OSO#03 Assurance Criterion #2;
- SORA v2.5 OSO#03 Integrity, SAIL V & VI – High (H);
- SORA v2.5 OSO#03 Assurance, SAIL V & VI – High (H);
- Light-UAS.2240; and
- Light-UAS.2340(b).

As regards OSO#03, ASTM F3366-19:

- ASTM F3366-19 uses the term "Maintenance Manual" vs. the SORA terms "Maintenance Instructions", "Maintenance Programme" and "Maintenance Procedures Manual". It can be considered that the "Maintenance Manual" referred to in the standard contains "Maintenance Instructions" and is part of the "Maintenance Programme" or "Maintenance Procedures Manual" from SORA;
- Sections 6 and 7 of this specification serve as templates for manufacturers to structure their GMM. For the technical content of the Maintenance Manual, F3366-19 refers to other standards (i.e., F2909, F2910, F3002, F3005).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.9.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3366-19 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3366-19			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
Light-UAS.2340(c)	SAIL III to VI	7.8	It addresses the requirement on a very high level with only very little detail added; thus, only partial coverage of the requirement.
Light-UAS.2340(d)	SAIL III to VI	6.7 7.6 7.7	Subsections 7.6.2.1 & 7.6.2.2 are not applicable (see non-recommended sections below) The list is not exhaustive and very high level.
Light-UAS.2370(c)	SAIL III to VI	7.7	It does not cover instructions for transportation
Light-UAS.2625	SAIL III to VI	7.7	It does not cover airworthiness limitations
OSO#03	SAIL I & II – Low (L) Criterion #1 Assurance	6	It addresses neither logging nor record-keeping of maintenance staff authorisations.
OSO#03	SAIL III & IV – Medium (M) Criterion #1 Assurance	6. 7.1 7.2 7.3 7.4.1 7.4.2 7.4.3 7.5	It addresses neither logging nor record-keeping of maintenance staff authorisations. Section 7.4.3 should state “if applicable”.

		7.6 7.6.1 7.7	
OSO#03	SAIL III & IV – High (H) Criterion #1 Assurance	6. 7.1 7.2 7.3 7.4.1 7.4.2 7.4.3 7.5 7.6 7.6.1 7.7	Recommended only for the common part with Medium (M).

3.9.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3366-19 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3366-19			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
7.6.2.1	Owner	Light-UAS.2340(d) OSO#03 SAIL III & IV – High (H) Criterion #1 Assurance	The EU equivalent (LUC) should be included. Only for SAIL IV, since for SAIL III no Remote Operating Certificate is required
7.6.2.2	UAS Repairman	Light-UAS.2340(d) OSO#03 SAIL III & IV – High (H) Criterion #1 Assurance	No CAA certification of maintenance personnel is required for SAIL I to IV. In the EU, no UAS repairman certification exists at the date of the review. Operators / applicants should be able to train their own personnel. The language should be adjusted to align it with UAS relevant maintenance roles and EASA references

3.10 ASTM F3379-20

3.10.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3379-20. Standard Guide for Training for Public Safety Remote Pilot of Unmanned Aircraft Systems (UAS) Endorsement* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSOs#09+, SAIL I to VI; and
  - OSO#19 Criterion #2, SAIL III to VI.
- EASA's remote crew training-related requirements:
  - AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);
  - AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e); and
  - AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3379-20 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.10.2 General remarks

ASTM F3379-20 provides the minimum training requirements, covering some theoretical and practical aspects of remote pilots' competencies.

This standard does not cover the following aforementioned requirement:

- AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.10.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3379-20 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3379-20			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSOs#09+	SAIL I to VI Integrity	Section 11	This section only addresses remote crew competencies on communication.
OSOs#09+	SAIL I to VI Assurance	Section 5	This section addresses the need of a training program/syllabus. Competency-based, theoretical and practical training are considered. The section refers to ASTM F3330 for training programs but the training syllabus may be developed based on operations.
OSOs#09+	SAIL I to VI Assurance	Section 14	This section only addresses remote crew's retention of qualification.
OSO#19 Criterion #2	SAIL III to VI Integrity	Section 11	Effective communication between crew members addressed in this section represents only a small part of CRM.
OSO#19 Criterion #2	SAIL III to VI Assurance	Section 5	This section addresses the need of a training program/syllabus. Competency-based, theoretical and practical training are considered. The section refers to ASTM F3330 for training programs but the training syllabus may be developed based on operations.

OSO#19 Criterion #2	SAIL III to VI Assurance	Section 14	This section only addresses remote crew's retention of qualification.
AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	Section 11	This section covers only multi-crew cooperation (MCC) and does not cover the other points of AMC1.
AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	Section 14 Annex A1	This section addresses initial and recurrent training, and the Basic Manoeuvring Lane but it does not address flights under abnormal situations and preparation of UAS operations (e.g., compliance with operational procedures, operational limitations and conditions, check of operational airspace, briefing participants, checklists, etc.) under the practical training.

3.10.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3379-20 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3379-20			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 10	Incident-specific Knowledge and Skills / Training for remote crew	OSOs#09+ Integrity SAIL I to VI AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	Specifications about how to evaluate environmental / weather conditions shall be provided.

3.11 ASTM F411-22a

3.11.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3411-22a. Standard Specification for Remote ID and Tracking* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- U-space IR (EU) 2021/664 Article 8 requirements on network identification service and its associated set of AMC & GM as published by EASA on 20th December, 2022.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3411-22a that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.11.2 General remarks

It is clear that ASTM F3411-22a is a robust standard for MoC for the Network Identification U-space service, due to its reference in the AMC & GM published by EASA on 20th December, 2022:

AMC4 Article 8(1) Network identification service

DATA EXCHANGE INTERFACE
USSPs should use the interface defined in Annex 4 to **ASTM F3411-22A** 'Standard Specification for Remote ID and Tracking'.

GM1 Article 8(1) Network identification service

GEOGRAPHIC PROXIMITY
Member States may support the definition of 'geographic proximity' by setting a value as part of the performance requirements established for each U-space airspace. Alternatively, the value provided in **ASTM F3411-22A** which specifies a rectangular area with a diagonal no greater than 7 km as a maximum display area may be used. Establishing a value for a geographic proximity smaller than the size of the U-space airspace limits the sharing of unnecessary data among the USSPs and thus supports the technical and economic efficiency of the network.

GM2 Article 8(1) Network identification service

TESTING INFRASTRUCTURE
To support the satisfaction of the U-space performance requirements as per Article 15(1) of Regulation (EU) 2021/664, a possible testing environment is presented in Annex A2 to **ASTM F3411-22A** 'Standard Specification for Remote ID and Tracking'.

AMC1 Article 8(2) Network identification service

ACCESS
USSPs should provide the authorised users defined in Article 8(4) of Regulation (EU) 2021/664 with access to aggregated network remote identification data using the communication protocol defined in Annex 4 to **ASTM F3411-22A** 'Standard Specification for Remote ID and Tracking'.

GM1 Article 8(3) Network identification service

UPDATE FREQUENCY

Competent authorities may use the value defined in **ASTM F3411-22A** 'Standard Specification for Remote ID and Tracking' as aggregated monthly target for update frequency (no more than 3 seconds for 95 % of the time, and in 1 second for 99 % of the time).

GM1 Article 8(4) Network identification service

ACCESS

USSPs may provide a visual interface to the authorised users to access data in accordance with items 5.5.5.6 to 5.5.5.8 of **ASTM F3411-22A** 'Standard Specification for Remote ID and Tracking'.

Further remarks are listed hereafter:

- GM1 to Article 8(3) has (probably by mistake) inverted the two percentage time values;
- No standard requirements have been found regarding AMC(3)(b) to Article 8(1) – Duration of the flight. The standard does not mention whether the network identification service should not be required when the UAS operator ends its flight.
- Section 4.3.1 'Actors and interfaces' as well as Appendix X3.3 'Use cases' did not go through a detailed assessment as no requirements are present; however, they can provide a conceptual overview regarding the main users of the service.
- Section 4.5 'Network Remote ID' did not go through a detailed assessment as no requirements are present; however, it can provide a conceptual overview for Article 8(1) regarding USSP receiving information from UAS during the flight.
- Since Article 8(4) is only providing background information on the list of authorised users referenced in Article 8(2), Article 8(4) assessment is covered through Article 8(2) assessment.
- The standard data fields cover each item of Article 8(2).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.11.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3411-22a that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3411-22a			
Requirement	**Related AMC & GM**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
NET-ID Article 8(1)	AMC3(a) to Article 8(1) – Duration of the flight	Section 5.5.2.4	N/A
	AMC2 to Article 8(1) – Continuous processing AMC1 to Article 8(1) – Provision of Aggregated UAS Remote Identification GM1 to Article 8(1) – Geographic Proximity	Section 5.5.4.4	EASA refers to the proposed 7 km for NetMaxDisplayAreaDiagonal defined in Section 5.5.4.4.
	AMC2 to Article 8(1) – Continuous processing AMC1 to Article 8(1) – Provision of Aggregated UAS Remote Identification GM1 to Article 8(1) – Geographic Proximity	Section 5.5.5.10	EASA refers to the proposed 7 km for NetMaxDisplayAreaDiagonal defined in Section 5.5.5.10.

	AMC1 to Article 8(1) – Provision of Aggregated UAS Remote Identification AMC4 to Article 8(1) – Data Exchange Interface	Annex A2.3	EASA AMC4 to Article 8(1) refers to Annex A4 which is referred to in Annex A2.3 so SHEPHERD's assessment is consistent with the published EASA AMC & GM.
	AMC1 to Article 8(1) – Provision of Aggregated UAS Remote Identification AMC4 to Article 8(1) – Data Exchange Interface	Annex A2.4	EASA AMC4 to Article 8(1) refers to Annex A4 which is referred to in Annex A2.4 so SHEPHERD'S assessment is consistent with the published EASA AMC & GM.
NET-ID Article 8(2)	GM1 to Article 8(4) – Access	Section 5.5.5	EASA GM1 to Article 8(4) calls sections 5.5.5.6 to 5.5.5.8 which are referring to Annex A4.
	GM1 to Article 8(2)(c) – Altitude above mean sea level AMC1 to Article 8(2)(c) – Altitude above mean sea level GM1 to Article 8(2)(f) – UAS emergency status	Section 5.3.1	N/A
	AMC1 to Article 8(2) – Access	Annex A4	EASA AMC1 to Article 8(2) calls Annex A4.
NET-ID Article 8(3)	GM1 to Article 8(3) – Update frequency	Section 5.5.2.4	GM1 to Article 8(3) has (probably by mistake) inverted the two percentage time values.
	GM1 to Article 8(3) – Update frequency	Section 5.5.4.4	GM1 to Article 8(3) has (probably by mistake) inverted the two percentage time values.

3.11.4 Non-recommended sections

No elements of ASTM F3411-22a have been deemed to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof.

3.12 ASTM F3442/F3442M-20

3.12.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ASTM F3442/F3442M-20. Standard Specification for Detect and Avoid System Performance Requirements* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA Annex D TMPR for ARC-b and ARC-c.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3442/F3442M-20 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.12.2 General remarks

The scope of the ASTM F3442/F3442M-20 is restricted to UA of less than 25 ft width, operating at less than 100 kts in low or medium risk airspaces.

This standard aims at covering a large number of types of UAS and thus provides a limited number of quantitative requirements, the main ones being the risk ratios. The methodology used is centred on the risk ratios and is not meant to be aligned with the functional decomposition used in Annex D of SORA.

Quantitative measures for the perception vs aircraft performance are provided as information only in an annex and cover different categories of UAS performances. These numbers need to be considered with caution for use in Europe considering:

- they have been derived from evaluations using encounter models representative of U.S. airspace only and it is unknown if they are applicable to Europe;
- the numbers related to a risk ratio analysis have been computed considering a "logic" risk ratio; this partially answers the risk ratio requirement, but leaves aside a certain number of considerations with respect to the "system" risk ratio considered in the SORA requirements (e.g., failure conditions, sensor uncertainty, human error, communication delays, etc.) as explained in the unpublished JARUS Annex G. The next version of the standard, to be published early 2024, should address this shortcoming.

Last but not least, ASTM F3442/F3442M-20:

- Being a performance standard, needs to define borders at which performance is measured, and proposes to rely in section 5.4 upon a definition accepted as relevant to its scope: the SARP/MIT/LL Well Clear recommendations as basis for DAA performance in the proposed standard. The ICAO SARP/MIT LL recommendations were developed 5 years ago based upon very broad and conservative assumptions of intruder aircraft and UA characteristics and performance. The result is an analysis that is almost completely insensitive to variability in key characteristics such as traffic density, aircraft relative speeds (particularly speeds below 500' AGL) and the ability of the UA to stop/hover/change direction; to be noted that the next version of this standard leaves the "door open" to other definitions of 'Well Clear'.

- Following a holistic approach, it does not address specifically each of the functional requirements of SORA Annex D. In particular, it does not address TMPR detect, TMPR execute and TMPR assurance requirements of SORA Annex D v2.0 as recognised by EASA; JARUS SORA v2.5 did not provide an update to Annex D.

To be noted that the Introductory sections, titles without associated text and more generally sections unrelated to TMPRs have been excluded from this assessment, as indicated in the preliminary assessment, which can be accessed here.

3.12.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ASTM F3442/F3442M-20 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3442/F3442M-20			
Requirement	**TMPR risk level**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
TMPR BVLOS – detect	ARC-b	None	
	ARC-c	None	
TMPR BVLOS – decide	ARC-b	6.3 6.4 8.2	Though not quantified, the proposed taxonomy is appropriate to describe the system latencies of interest.
	ARC-c	6.3 6.4 8.1 8.2 8.3	Though not quantified, the proposed taxonomy is appropriate to describe the system latencies of interest. A limited number of requirements contribute to the HMI requirements for arc-c.
TMPR BVLOS – command	ARC-b	6.5 9.3	Though not quantified, the proposed taxonomy is appropriate to describe the system latencies of interest.
	ARC-c	6.5 9.3	Though not quantified, the proposed taxonomy is appropriate to describe the system latencies of interest.
TMPR BVLOS – execute	ARC-b	None	
	ARC-c	None	

TMPR BVLOS – feedback loop	ARC-b	8.3 9.2	Provided latencies relationships allow deriving requirements once the latencies are quantified.
	ARC-c	8.3 9.2	Provided latencies relationships allow deriving requirements once the latencies are quantified.
TMPR BVLOS – Integrity	ARC-b	5.5.2	Matches requirements from SORA
	ARC-c	5.5.2	Matches requirements from SORA
TMPR BVLOS – Assurance	ARC-b	None	
	ARC-c	None	
TMPR BVLOS – Risk ratio	ARC-b	5.4	See general remark on consideration of ICAO SARP. It addresses computation of the “logic” risk ratio, a subset of the “system” risk ratio.
	ARC-c	5.4	

3.12.4 Non-recommended sections

This subsection provides the list of elements of ASTM F3442/F3442M-20 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ASTM F3442/F3442M-20			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
5.3	Safety	TMPR BVLOS – Risk ratio ARC-b & ARC-c	Alignment with SORA air risk classification.
5.5.3	DAA System Assurance	TMPR BVLOS – Assurance ARC-b & ARC-c	It is recommended to provide rationale and updated numbers for the number of allowed hazardously misleading information. This should be present in the next version of this standard.
X1.3	Surveillance Requirements Tables	TMPR BVLOS – Risk ratio ARC-b & ARC-c	Derive numbers based on encounter models that include European models

3.13 ED-12C & ED-80

3.13.1 Introduction

The objective of this section is to present the outcome of the technical assessment of *ED-12C. Software Considerations in Airborne Systems and Equipment Certification* & *ED-80. Design Assurance Guidance for Airborne Electronic Hardware* conducted by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSO#05, SAIL V & VI;
  - OSOs#10+, SAIL V & VI;
- SORA Annex E v2.5 section 4 requirements for the containment of the operation (Step #8) Criterion #4;
- EASA SC Light-UAS – Medium & High Risk provisions:
  - Light-UAS.2510(a); and
  - Light-UAS.2511(b)(3).

3.13.2 Assessment and conclusion

The assessment of ED-12C & ED-80 was done in deviation from the SHEPHERD methodology for the following reasons:

- The mention of software or electronic hardware development assurance processes to reduce the likelihood of development error(s) is bound to very specific wording both in EASA SC Light-UAS and JARUS SORA v2.5 released for external consultation;
- The following table summarises the cases where the risk of development errors is mentioned both in EASA SC Light-UAS and JARUS SORA v2.5 released for external consultation:

ED-12C & ED-80	
EASA SC Light-UAS	**JARUS SORA v2.5 released for external consultation**
Light-UAS.2511(b)(3) – Containment *When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer:* ***software and airborne electronic hardware whose development error(s) could directly lead to operations outside the ground risk buffer*** *must be developed to a standard or methodology accepted by the Agency*.	SORA Annex E v2.5 section 4 requirements for the containment of the operation (Step #8) Criterion #4 – Medium (M) & High (H): ***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*.
Note: *The use of the term 'directly' means that a development error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for*	The note introduced in the EASA SC light-UAS to clarify the use of the term "directly" does not exist in the JARUS document but the intent is the same.

another means to prevent the UA from exiting the operational volume.	
No equivalent in SC Light-UAS.2510(a)	OSO#5, SAIL V & VI – High (H) level of Integrity: *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*.
No equivalent in SC Light-UAS.2510(a)	Note: *Development Assurance Levels (DALs) for SW/AEH may be derived from JARUS AMC RPAS.1309 Issue 2 Table 3 depending on the UAS class or an equivalent risk-based methodology acceptable to the competent authority*.
No equivalent in SC Light-UAS.2510(a)	OSOs#10+, SAIL V & VI – High (H) level of Integrity: *When operating over population density above 2,500 ppl/km2,* ***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*.
No equivalent in SC Light-UAS.2510(a)	Note: *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*.

- There are no criteria contained in EASA SC Light-UAS and JARUS SORA v2.5 released for external consultation which would allow an objective assessment of the ED-12C & ED-80 standards.

That said, it is known that using development assurance processes meeting the objectives of ED-12C & ED-80 standards is time- and labour-intensive and despite the fact that the standards have shown a significant role in the previous development of safety-critical systems embedded in traditional commercial manned aircraft, the standards are not considered adequate for small UAS having very short SW/AEH life-cycles (e.g., 6 weeks vs more traditionally 6 months), even when operated in SAIL V or SAIL VI 'specific' category of operations.

In conclusion, the ED-12C & ED-80 should not be considered as appropriate standards to be used by the industry for the development of softwares / (complex) electronic hardwares intended to be used on UAS having short SW/AEH life-cycles. However, they could be considered as appropriate standards for the development of softwares / (complex) electronic hardwares intended to be used on UAS with longer SW/AEH life-cycles when operated in SAIL V or SAIL VI 'specific' category of operations and impacted by the requirements expressed in the following requirements:

- OSO#05 Integrity;
- OSOs#10+ Integrity;
- Light-UAS.2511(b)(3); and
- SORA Annex E v2.5 section 4 requirements for the containment of the operation (Step #8) Criterion #4 – High (H) level of Integrity.

3.14 ED-269

3.14.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ED-269. Minimum Operational Performance Standard for Geo-Fencing* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA Annex E v2.5 section 4 requirements for the containment of the operation (Step #8);
- EASA SC Light-UAS.2511(b) – Medium & High Risk; and
- U-space IR (EU) 2021/664 Article 5 requirements on common information services (CIS) and its associated set of AMC & GM as published by EASA on 20th December, 2022.

Note: It was agreed with EASA not to make an additional detailed assessment of ED-269(-) against U-Space IR (EU) 2021/664 Article 9 on the geo-awareness service, since the geo-awareness service is a U-space service that provides 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.

This document identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ED-269 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.14.2 General remarks

Based on the content of Section 1.3 of the ED-269, it is clear that the standard does not address any of the containment safety requirements of SORA Step#8 or SC Light-UAS.2511(b); instead, the ED-269 is rather devoted to functional requirements to avoid the UA to penetrate a forbidden zone and/or provide information where the UA is allowed to operate.

As well, based on the following paragraph of Section 1.1: "*This standard specifies the data model and interface protocol for the delivery of the UAS geographical zone information to UAS and users, independently of the way this information is developed and maintained. This specification is gathered in chapter 8, 9 and Appendix 2.*", the suitability of the standard as AMC/GM for U-Space regulation 2021/664 Article 5 was performed only on Chapters 8, 9 and Appendix 2.

The recommended sections of ED-269 for suitability of the standard as AMC/GM for U-Space IR (EU) 2021/664 Article 5 are summarised afterwards and are aligned with the AMC & GM material published by EASA on 20th December, 2022:

AMC1 Article 5(1) Common information services

FORMAT OF AIRSPACE INFORMATION

The format of airspace information, including geographical zones, static and dynamic airspace restrictions, adjacent U-space airspace, and the horizontal and vertical limits of the U-space airspace should be as described in Chapter VIII 'UAS geographical zone data model' of and **Appendix 2 to the**

ED-269 'MINIMUM OPERATIONAL PERFORMANCE STANDARD FOR GEOFENCING' standard in the version published in June 2020.

GM1 Article 5(1)(b) Common information services

GEO-ZONE DATA FORMAT

Member States may define a format and data model to support the electronic sharing of information. They may use the JSON format (rfc7159) defined in **EUROCAE ED-269**. To support interoperability, Member States are encouraged to refer to standards and ensure consistency as regards the naming convention.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.14.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ED-269 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-269			
Requirement	**Related AMC & GM**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
Article 3(4) as referenced by CIS Article 5(1)(b)	GM3 Article 3(4) U-space airspace — Internal geographical zones	8.1.1 UASZone 8.1.4 TimePeriod 8.1.5 DailyPeriod 8.1.6 Authority 8.2.6 CodeRestrictionType 8.2.8 CodeZoneReasonType	The identified structure of the Data model supports operation both inside and outside of U-Space. However aspects such as the performance limitations and service performance requirements as defined in the standard are completely open nature. Data providers may choose to use it in any language, form and degree of complexity they may choose and this is against the principles of interoperability as any provider in any U-space can provide restrictions in a way that is not interoperable with another U-space airspace restriction format.
CIS Article 5(1)(a) CIS Article 5(1)(e) CIS Article 5(1)(f)	N/A	8.1.1 UASZone 8.1.2 UASZoneVersion 8.1.3 AirspaceVolume 8.1.4 TimePeriod 8.1.5 DailyPeriod 8.2.3 CodeZoneIdentifierType 8.2.4 CodeCountryISOType 8.2.10 CodeUSpaceClassType	
CIS Article 5(1)	AMC1 Article 5(1) Common information	8.1.1 UASZone 8.1.2 UASZoneVersion	These sections are applicable as the schema to be used is mandated by the standard but partial coverage due to lack

	services - Format of Airspace Information	8.1.3 AirspaceVolume 8.1.4 TimePeriod 8.1.5 DailyPeriod 8.2.3 CodeZoneIdentifierType 8.2.4 CodeCountryISOType 8.2.10 CodeUSpaceClassType combined with the following entries from APPENDIX 2: – Information Definition – UASZoneVersion – AirspaceVolume – ApplicableTimePeriod – Authority – Example of a UASZoneVersion – Extending the UASZoneVersion – Messages	of dedicated fields for adjacent U-space airspace information.
CIS Article 5(1)	AMC2 Article 5(1) Common information services - Interfaces	The following entries from APPENDIX 2: – Information Definition – UASZoneVersion – AirspaceVolume – ApplicableTimePeriod – Authority – Example of a UASZoneVersion – Extending the UASZoneVersion – Messages	These sections are applicable as the schema to be used is mandated by the standard and therefore this information is needed to implement the interface by the data users but partial coverage as the standard does not cover the identification and implementation of the interface for aspects such as the terms of service and the USSP information in 5(1)(c).
CIS Article 5(1)	GM1 to Article 5(1)(b) - Geo-zone data format	The following entries from APPENDIX 2: – Information Definition – UASZoneVersion – AirspaceVolume – ApplicableTimePeriod – Authority – Example of a UASZoneVersion	These are applicable as the schema to be used is mandated by the standard and therefore this information is needed to provide geozone data in the geo-zone data format.

		– Extending the UASZoneVersion – Messages	
Annexes II and III as referenced by CIS Article 5(4)		8.1.8 Metadata 9.1.2 Functional Overview 9.1.3 Non Functional Overview 9.2.1 Interfaces Overview 9.2.5.1 Getting an initial UASZone baseline and then receive UASZone updates ensuring there are no information gaps between initial baseline and updates 9.2.2.4 Interface Binding Description 9.2.3.7 Interface Binding Description 9.2.4.4 Interface Binding Description	The standard sections identified address both the requirements associated with enabling all users to access the data and to access it securely. That said, they are designed around a prescribed implementation, such as the interface and related use of specified protocols; the new Data provisioning and Exchange standard worked on by EUROCAE WG105 SG3 will provide alternative means to achieve the same goals that are implementation agnostic. As well, only partial coverage is considered primarily due to the open nature structure of the restrictions conditions which does not support interoperability since any data provider could create any structure, in any language, in any U-space airspace which would not be interoperable with another U-space airspace.
CIS Article 5(5)	AMC1 to Article 5(5) Common information services - Instructions to CIS Users	9.2.2.4 Interface Binding Description 9.2.3.7 Interface Binding Description 9.2.4.4 Interface Binding Description	The interface binding specification is required to be able to grant access to the common information services.
		The following entries from APPENDIX 2: – Information Definition – UASZoneVersion – AirspaceVolume – ApplicableTimePeriod – Authority – Example of a UASZoneVersion – Extending the UASZoneVersion – Messages	The schema is required so that USSPs can configure their interfaces and systems to properly support the provision of services.

CIS Article 5(6)	AMC1 to Article 5(6) Common information services – Instructions to CIS Users	9.2.2.4 Interface Binding Description 9.2.3.7 Interface Binding Description 9.2.4.4 Interface Binding Description	The interface binding specification is required to be able to grant access to the common information services.
		The following entries from APPENDIX 2: – Information Definition – UASZoneVersion – AirspaceVolume – ApplicableTimePeriod – Authority – Example of a UASZoneVersion – Extending the UASZoneVersion – Messages	The schema is required so that USSPs can configure their interfaces and systems to properly support the provision of services.

Note: Article 3(4) is shown in the table above as it is referenced in Article 5(1)(b) of U-space IR (EU) 2021/664.

3.14.4 Non-recommended sections

This subsection provides the list of elements of ED-269 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-269			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement**	**Required tailoring / complementing**
8.2.7 ConditionExpressionType		AMC2 Article 3(4), GM3 Article 3(4) and GM12 Article 3(4), Article 5(1)(f)	The restriction structure as specific is completely open nature. Data providers may choose to use it in any language, form and degree of complexity they may choose, this is against the principles of interoperability as any provider in any U-space can provide restrictions in a way that is not interoperable with another U-space airspace restriction format. This item is being addressed as part of the new Data provisioning and Exchange standard worked on by EUROCAE WG105 SG3.
8.2.5 CodeZoneType		GM12 Article 3(4)	The restriction format, limiting access by individual UAS type, requires changing to a performance driven objective as the management via individual make/model is not scalable. This item is being addressed as part of the new Data provisioning and Exchange standard worked on by EUROCAE WG105 SG3.
8.2.11 GeoShapeType		Article 5(1)(a)	The definition of a circle in the standard should be accompanied by an accuracy target which enables an outcome-based approach to ensuring all USSPs interpret non-regular polygon geometry in the same way. This item is being addressed as part of the new Data provisioning and Exchange standard worked on by EUROCAE WG105 SG3.

3.15 ED-270

3.15.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ED-270. Minimum Operational Performance Standard for Geocaging* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8); and
- EASA SC Light-UAS.2511(b) – Medium & High Risk.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ED-270 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.15.2 General remarks

First of all, considering that ED-270 was developed with reference to EASA AMC1 to Article 11 of (EU) 2019/947 and SORA v2.0, it is recommended that EUROCAE launches a review of ED-270 once an update to this AMC (based on SORA v2.5) is published.

Section 1.3 of ED-270 provides clarifications on the intent of the Geo-Caging MOPS covered by the standard which are deemed worth being highlighted in the assessment summary:

- The Geocaging function has three grades defined to accommodate different levels of risk in case of exit;
- The Geocaging function provides, depending on the grade, one or several barriers to the exit;
- These barriers can be alerts to the remote pilot that will perform the adequate actions or, optionally, can be automatic actions; and
- A flight termination system may be included in the Geocaging function to achieve the required safety objective, specifically for High grade, but this is not a preferred or imposed solution.

The preliminary high-level assessment, accessible here, highlights that many requirements related to the Geocaging function's first and second grades are not addressing specifically the containment requirements of EASA SC Light-UAS.2511(b) or SORA v2.5 Step#8 (detailed in Annex E section 4).

Nevertheless, those latter ED-269 requirements which are not proposed to be included as MoC may be viewed, pending on each specific design and application, as recommended good design practices that would contribute to the overall safety of the containment.

As well, the preliminary high-level assessment highlights that other requirements are at the same level as EASA SC Light-UAS.2511(b) or SORA Step#8 requirements without further detail provided to help show compliance with these requirements. For instance:

- REQ032 is equivalent to SORA v2.5 Annex E Step#8 Criterion #1 for Low (L) & Medium (M) and SC Light-UAS.2511(a);
- REQ033 is equivalent to SORA v2.5 Annex E Step#8 Criterion #1 for High (H) and SC Light-UAS.2511(b)(1);

- REQ035 is equivalent to SORA v2.5 Annex E Step#8 Criterion #4 for Medium (M) & High (H) and SC Light-UAS.2511(b)(2);
- REQ044 is partially equivalent to SORA v2.5 Annex E Step#8 Criterion #4 for Medium (M) & High (H) and SC Light-UAS.2511(b)(3), except for the DAL C requirement which is prescriptive and not risk-based.

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.15.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ED-270 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-270			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
SORA v2.5 Annex E Step#8 (Containment) Criterion #2	Integrity – Low (L), Medium (M) & High (H)	Section 3.3.1 **REQ038** combined with Section 3.3.2 requirements **REQ040, REQ039, REQ041, REQ042 & REQ046** and Appendix 1 sections *2 Intro "Geocaging parameter setting"* & *2b "Recommended overall computation procedure"*	A system meeting the **emergency warning alerts and <u>manual</u> emergency command** requirements contained in ED-270 section 3.3.2 can be considered as meeting the SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #2 Integrity.
		Section 3.3.1 **REQ038** combined with section 3.3.3 requirements **REQ043 & REQ047** and Appendix 1 sections *2. Intro "Geocaging parameter setting"* & *2b. "Recommended overall computation procedure"*	A system meeting the **emergency warning alerts and <u>automatic</u> emergency command** related requirements contained in ED-270 section 3.3.3 can be considered as meeting the SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #2 Integrity .
SORA v2.5 Annex E Step#8 (Containment) Criterion #2	Assurance – Low (L), Medium (M) & High (H)	Section 5.3 **TST018** for REQ038 & Section 5.2 **TST005** combined with **Appendix 1 sections *2. intro "Geocaging parameter setting" & 2b. " Recommended overall computation procedure*"** for REQ046	For systems implementing a **<u>manual</u>** emergency command

		& Section 5.3 **TST014** for REQ039 & REQ040 & Section 5.3 **TST015** for REQ041 & REQ042 & Section 5.3 **Recommendation for sharing effectiveness tests TST015 between real flights testing / ground bench testing / simulations**	
		Section 5.3 **TST018** for REQ038 & Section 5.2 **TST005** combined with **Appendix 1 sections *2. Intro "Geocaging parameter setting"* & *2b. " Recommended overall computation procedure"*** for REQ047 & Section 5.3 **TST015** for REQ043 (automatic command) & Section 5.3 **Recommendation for sharing effectiveness tests TST015 between real flights testing / ground bench testing / simulations**	For systems implementing an **automatic** emergency command

3.15.4 Non-recommended sections

This subsection provides the list of elements of ED-270 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-270			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Section 3.3.1 **REQ037**	Common requirements	– SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #4 Integrity – Medium (M) & High (H) – Light-UAS.2511(b)(2), SAIL III to VI	REQ037 states "*one Geocaging channel at least should stay active even in the case of loss of C2 link*", which is a way to address Light-UAS.2511(b)(2) or SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #4 Integrity – Medium (M) & High (H), but limited to C2 link loss.
Section 5.2 **TST004**	Reliability analysis	– SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #1 Assurance – Low (L), Medium (M) & High (H) – SORA v2.5 Annex E section 4 Containment Requirements (Step#8) Criterion #4 Assurance – Medium (M) & High (H) – Light-UAS.2511(b)(1), SAIL III to VI	TST004 does not specifically address how to make a design and installation appraisal (only mention FMEA), nor it addresses specifically particular risks (only mention common mode analysis for high grade).

Additionally, as already noted under the general remarks, it is recommended that EUROCAE launches a review of ED-270 once an update to this AMC (based on SORA v2.5) is published.

3.16 ED-279

3.16.1 Introduction

The objective of this section is to present the outcome of the technical assessment of *ED-279. Generic Functional Hazard Assessment (FHA) for UAS / RPAS* conducted by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSO#05 – SAIL III to VI;
- SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8);
- EASA SC Light-UAS – Medium & High Risk provisions:
    - Light-UAS.2400(c);
    - Light-UAS.2510;
    - Light-UAS.2511(a); and
    - Light-UAS.2511(b)(2).

On the one hand, ED-279 proposes, in its whole, a methodology to perform a UAS / RPAS Functional Hazard Assessment (FHA), which is either the starting point to perform a detailed safety assessment or a simplified one as implicitly required by the above requirements.

On the other hand, there are no specific criteria in EASA SC Light-UAS or draft JARUS SORA v2.5 released for external consultation (with the exception of the general reference to ED-280 in OSO#5) regarding a methodology for detailed safety assessment process activities that would allow to show compliance with the SC Light-UAS or SORA requirements themselves, but rather deals with general safety objectives.

Consequently, it has been considered that, in this particular case, there was no point of performing the assessment of the standard, section by section; instead, a general assessment and subsequent recommendations are directly provided through this assessment report.

3.16.2 General remarks

- OSO#05, SAIL III and SAIL IV – Low (L) and Medium (M) Integrity criteria require that "*the equipment, systems and installations are designed to minimise hazards in the event of a probable failure of the UAS*"; subsequently, OSO#05, SAIL III and SAIL IV – Low (L) and Medium (M) Assurance Criteria require a Functional Hazard Assessment and a design and installation appraisal to support demonstrating that "*hazards are minimised*"; additional OSO#05, SAIL IV Assurance Criterion adds up the need to perform safety analyses in line with acceptable standards and also a strategy for the detection of single failures of concern that includes pre-flight check.

- OSO#05, SAIL V & VI – High (H) Integrity criterion goes one step further in dealing with the required relationship between failure severity (Major, Hazardous and Catastrophic) and probability and software / complex hardware development activities. But the OSO#05, SAIL V & VI – High (H) Assurance criterion builds on OSO#05, SAIL III and SAIL IV Low (L) and Medium (M) Assurance Criteria that require a Functional Hazard Assessment.

- Light-UAS.2510(a)(1) – Medium Risk matches OSO#05, SAIL III & IV. In addition, Light-UAS.2510(a)(2) addresses the handling of single failure.

- Light-UAS.2510(a)(1)&(a)(2)&(a)(3) – High Risk (SAIL V & VI) address the relationship between failure severity and probability in line with OSO#5, SAIL V & VI – High (H) Integrity Criteria. In

addition, Light-UAS.2510(a)(1) – High Risk adds the "single failure" requirement (*No single failure shall cause a Catastrophic Event*).

- Light UAS.2400(c) basically refers to Light-UAS.2510, so the Lift/Thrust/Power systems hazards are to be assessed in accordance with Light-UAS.2510.

- SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8) (as well as in Light-UAS.2511(a)&(b)(2) – Medium and High Risk) do not directly refer to a Functional Hazard assessment but focus on the failure condition "*UA leaving the operational volume*"; this means that an FHA will help supporting compliance with SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8) by identifying the functional failures leading to the failure condition "*UA leaving the operational volume*".

- In order to show compliance with the above requirements, some safety analysis will have to be performed at a level of detail which is proportional to the risk of the operations (SAIL).

- The first step to prepare any of the safety analyses needed to show compliance with requirements quoted in previous paragraph is to establish a UAS / RPAS Functional Hazard Assessment, before analysing the way the various functions are implemented at system / subsystem levels and carrying on these safety analyses.

Note: OSO#5, SAIL IV – Medium (M) Integrity criteria and Light-UAS.2510(a)(3) – Medium Risk add that "*the strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard is available*". Whilst this requirement needs the support of safety analyses to identify relevant malfunctions and failure conditions, it is also a design requirement.

3.16.3 Recommendations for inclusion in a MoC

- ED-279 provides a thorough methodology to perform a Functional Hazard Assessment including identification of generic UAS functions, functional failure severity classification and illustrating examples as well as applicability to fixed wing and rotorcraft configuration.

- ED-279 may be quoted as the first necessary step in a MoC referring to safety analyses required to comply with the following requirements:

    - SORA v2.5 OSO#5, SAIL III to VI;
    - Light-UAS.2510(a)(1)&(a)(2) and Light-UAS.2400(c) – Medium Risk (SAIL III & IV);
    - Light-UAS.2510(a)(1)&(a)(2)&(a)(3) and Light-UAS.2400(c) – High Risk (SAIL V & VI);
    - SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8) – Criterion #1 and Light-UAS.2511(a)&(b)(2) – Medium & High Risk by identifying the functional failures leading to the failure condition "*UA leaving the operational volume*".

Note: the recommendation for OSO#05 is aligned with SORA v2.5 for which OSO#5 criteria refer to EUROCAE ED-280 "*Guidelines for UAS safety analysis for the specific category (low and medium levels of robustness)*" that may be considered acceptable by the competent authority as a means of compliance, while ED-280 refers itself to ED-279.

3.16.4 Recommendations for completion

- Whilst ED-279 does address the functional failure severity classification, it does not address the relevant quantitative probability objectives and Development Assurance level to be met as a function of this classification. These will have to be added once the final EASA AMC to Light-UAS.2510 is established.

- Being only the first step as above mentioned, ED-279 needs to be complemented by additional guidelines to prepare the system safety analyses to show compliance with above requirements at an extent commensurate to Medium or High Risk requirements.

3.17 ED-280

3.17.1 Introduction

The objective of this section is to present the outcome of the technical assessment of *ED-280. Guidelines for UAS Safety Analysis for the Specific Category (Low and Medium Levels of Robustness)* conducted by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSO#05, SAIL III to VI;
- SORA TMPR Integrity requirements;
- SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8);
- EASA SC Light-UAS – Medium & High Risk provisions:
    - Light-UAS.2400(c);
    - Light-UAS.2510;
    - Light-UAS.2511(a); and
    - Light-UAS.2511(b)(1)&(2).

3.17.2 General remarks

ED-280 was specifically developed to provide, in its whole, guidelines for a UAS operator or manufacturer in order to:

- obtain the evidence(s) that the UAS is designed considering system safety and reliability; and
- perform the required safety analyses to fulfil part of OSO#05 requirements, for Low (L) and Medium (M) levels of robustness (respectively applicable to SAIL III and SAIL IV, as part of the SORA risk assessment).

Considering that ED-280 clearly states it is only applicable to OSO#05 Low (L) and Medium (M) levels of robustness, this assessment only covers the suitability of ED-280 to SAIL III and SAIL IV.

In addition, there are no specific criteria in EASA SC Light-UAS or JARUS SORA v2.5 released for external consultation (with the exception of the general reference to ED-280 in OSO#05) regarding a methodology for *detailed* safety assessment process activities that would allow to show compliance with the SC Light-UAS or SORA requirements themselves, but it rather deals with general safety objectives.

Consequently, it has been considered that, in this particular case, there was no point of performing the assessment of the standard, section by section; instead, a general assessment and subsequent recommendations are directly provided through this assessment summary.

3.17.3 Technical assessment

SORA v2.5 OSO#05, SORA v2.5 Step#8, Light-UAS.2510 and Light-UAS.2511 are quite well correlated (see comparison tables below).

The following table presents the comparison between SORA v2.5 OSO#05 and Light-UAS.2510:

EASA SC Light-UAS.2510 – Medium risk (SAIL III & IV)	**JARUS SORA v2.5 OSO#05 Integrity**	**JARUS SORA v2.5 OSO#05 Assurance** **(no equivalent in SC Light-UAS – see Light-UAS.2510 Note 4)**

Light-UAS.2510(a)(1) *The equipment and systems identified in CS-Light UAS.2500, considered separately and in relation to other systems, must be designed and installed such that hazards are minimised in the event of a probable failure.*	OSO#05 Integrity – Low (L) & Medium (M) (SAIL III & IV) *The equipment, systems, and installations are designed to minimise hazards in the event of a probable malfunction or failure of the UAS.*	OSO#05 Assurance – Low (L) & Medium (M) (SAIL III & IV) *A Functional Hazard Assessment(1) and a design and installation appraisal that shows hazards are minimised are available* *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.* *(1) Severity of failure conditions (No Safety Effect, Minor, Major, Hazardous and Catastrophic) should be determined according to the definitions provided in JARUS AMC RPAS.1309 Issue 2.*
Light-UAS.2510 Note 1 *The term 'probable' needs to be understood in its qualitative interpretation, i.e. 'Anticipated to occur one or more times during the entire system/operational life of an item.'*	OSO#05 Comment 2 *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 a UAS".*	
Light-UAS.2510 Note 2 *The term 'failure' needs to be understood as an occurrence that affects the operation of a part, or element such that it can no longer function as intended (this includes both loss of function and malfunction). Errors may cause failures, but are not considered to be failures. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.*	[SHEPHERD comment]: The term failure is not defined in SORA but the definition proposed by EASA SC Light-UAS.2510 is compatible.	

Light-UAS.2510 Note 3 *The term "hazard" needs to be understood as a failure condition that relates to major, hazardous or catastrophic consequences.*	OSO#05 Comment 1 *For the purpose of this assessment, the term "hazard" should be interpreted as a failure condition that relates to major, hazardous, or catastrophic.*	
Light-UAS.2510(a)(2) *The equipment and systems identified in CS-Light UAS.2500, considered separately and in relation to other systems, must be designed and installed such that it can be reasonably expected that a catastrophic failure condition will not result from any single failure.*	OSOs#10+ Integrity – Medium (M) (SAIL III & IV) *When operating over population density above 2,500 ppl/km2, no single failure of the UAS or any external system supporting the operation will lead to a fatality(ies).*	[SHEPHERD comment]: The safety analyses techniques requested to show compliance with Light-UAS.2510(a)(2) are equivalent to SORA v2.5 OSO#05.
Light-UAS.2510 Note 4 *MOC for Light-UAS.2510 (medium risk) will be defined by EASA at a later stage*		
Light-UAS.2510 Note 5 *(a)2 is transposed from OSO 10/12 of EASA AMC and GM "when operating over populated areas or assemblies 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"*		Severity of failure conditions (No Safety Effect, Minor, Major, Hazardous and Catastrophic) should be determined according to the definitions provided in JARUS AMC RPAS.1309 Issue 2. [SHEPHERD comment]: According to JARUS definition, only failure conditions leading to a fatality are considered catastrophic.
Light-UAS.2510(a)(3) – SAIL IV only *The equipment and systems identified in CS-Light UAS.2500, considered separately and in relation to other systems, must be designed and installed such that if the SAIL is IV, a means for detection, alerting and management of any failure or combination thereof, which would lead to a hazard, is available.*	OSO#05 Integrity – Medium (M) (SAIL IV) *In addition, the strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard is available.*	A strategy for the detection of single failures of concern includes pre-flight checks.

Light-UAS.2510(b) *Any hazard which may be caused by the operation of equipment and systems not covered by Light-UAS.2500 must be minimised.*	OSO#05 Integrity – Low (L) & Medium (M) (SAIL III & SAIL IV) *The equipment, systems, and installations are designed to minimise hazards in the event of a probable malfunction or failure of the UAS.*	
No equivalent – see above Light-UAS.2510 Note 4	OSO#05 Comment 3 *Eurocae ED-280 "Guidelines for UAS safety analysis for the specific category (low and medium levels of robustness)" may be considered acceptable by the competent authority to support compliance with this criterion.*	

SORA Annex D TMPR integrity requirements do not provide specific criteria related to safety assessment and thus are not considered in this assessment.

The conclusion on the suitability of ED-280 for SORA v2.5 OSO#05 and Light-UAS.2510 can be re-used directly for the other requirements in scope for the reason stated below:

- EASA SC Light-UAS.2400(c): showing compliance with Light-UAS.2510 directly supports demonstration of compliance with Light-UAS.2400(c), since Light-UAS.2400(c) refers to Light-UAS.2510: "*The hazards in the event of a malfunction or failure of the Lift/Thrust/Power Control Systems and the Lift/Thrust/Power System Installation need to be assessed and mitigated in accordance with the airworthiness standards Light-UAS.2500 and Light-UAS.2510*".
- Compliance with EASA SC Light-UAS.2511 as well as SORA v2.5 Annex E Step#8 – Criterion #1 (Low, Medium, High) & Criterion #4 (Medium, High) rely on a Functional Hazard Assessment and an installation appraisal, as required by SORA v2.5 OSO#05 and Light-UAS.2510. See below comparison table:

Requirement **Light-UAS.2511 / SORA v2.5 Step#8**	**Compliance method**	**JARUS SORA v2.5 OSO#05 Assurance criteria for comparison**
SAIL III to VI SC Light-UAS.2511(a) *No probable failure of the UAS or of any external system supporting the operation must lead to operation outside the operational volume.*	Note (Part 1) *Compliance with the airworthiness standard referred to in point (a) should be substantiated by a design and installation appraisal and should include at least:* *– The design and installation features (independence, separation and redundancy);* *– Any relevant particular risk (e.g. hail, ice, snow,*	SAIL III to VI A Functional Hazard Assessment and a design and installation appraisal that shows hazards are minimised are available. In addition, safety analyses are conducted in line with standards considered adequate by the competent authority and/or in accordance with a

	electro-magnetic interference, etc.) associated with the operation.	means of compliance acceptable to that authority.
SAIL III to VI SC Light-UAS.2511(b)(1) *When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer, the probability of leaving the operational volume must be demonstrated to be acceptable with respect to the risk posed by a loss of containment.* SAIL III to VI SC Light-UAS.2511(b)(2) *When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer, no single failure of the UAS or of any external system supporting the operation must lead to its operation outside the ground risk buffer.*	Note (Part 1) *Compliance with the airworthiness standard referred to in points (b)(1)&(2) should be substantiated by analysis and/or test data with supporting evidence.*	SAIL III to VI See above
SORA v2.5 Annex E Step #8 Criterion #1 – Low (L) and Medium (M) (Qualitative) *No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operation volume.* OR (Quantitative) *The probability of the failure condition "UA leaving the operational volume" considering all failure modes of interest shall be less than 10-3/Flight Hour (FH).*	*Compliance is to be substantiated by a design and installation appraisal and includes as a minimum:* *– design and installation features (independence, separation and redundancy);* *– any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the operation.*	SAIL III to VI See above

SORA v2.5 Annex E Step #8 Criterion #1 – Low (L) and Medium (M) (Qualitative) *No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operation volume.* OR (Quantitative) *The probability of the failure condition "UA leaving the operational volume" considering all failure modes of interest shall be less than 10-3/Flight Hour (FH).*	*Compliance is to be substantiated by a design and installation appraisal and includes as a minimum:* *– design and installation features (independence, separation and redundancy);* *– any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the operation.*	SAIL III to VI See above
SORA v2.5 Annex E Step #8 Criterion #1 – High (H) (Qualitative) *No remote failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.* OR (Quantitative) *The probability of the failure condition "UA leaving the operational volume" considering all failure modes of interest shall be less than 10-4/FH.*	*Compliance is to be substantiated by a design and installation appraisal and includes as a minimum:* *– design and installation features (independence, separation and redundancy);* *– any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the operation.*	SAIL III to VI See above
SORA v2.5 Annex E Step #8 Criterion #4 – Medium (M) and High (H) *No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer.*	Not specified	SAIL III to VI See above

3.17.4 Recommendations for inclusion in a MoC

ED-280 (Chapter 3) provides a thorough methodology and defines all the steps to perform a safety analysis to show compliance with SORA v2.5 OSO#05 Medium (M) levels of robustness (SAIL III & IV) and correlated EASA SC Light-UAS.2510 – Medium Risk (SAIL III & IV) as explained above, namely:

- It has clearly derived safety objectives from SORA v2.5 OSO#05 / SC Light-UAS.2510 requirement, in particular: "*The equipment, systems, and installations are designed to minimise hazards in the event of probable malfunction of failure of the UAS*";
- It has outlined the general guidelines to show that these safety objectives are met through the identification of the failure conditions and their severity classification, based upon a Function Hazard Assessment and review of system Architecture and functional implementation and subsequent qualitative Fault Tree Analysis for Major, Hazardous and Catastrophic failure conditions.

ED-280 may, thus, be quoted in a MoC (in line with current JARUS SORA v2.5 recommendation) referring to safety analyses required to comply with the following requirements:

- SORA v2.5 OSO#05, SAIL III and SAIL IV, at the exception of the requirements requesting a strategy for detection, alerting and management (for SAIL IV) of any malfunction, failure or combination thereof, which would lead to a hazard;
- SORA v2.5 Annex E Step#8 Criterion #1 – Low (L), Medium (M) & High (H) and Criterion #4 – Medium (M) & High (H);
- Light-UAS.2510(a)(1)&(a)(2)&(b) for Medium Risk (SAIL III & IV);
- Light-UAS.2400(c) for Medium Risk (SAIL III & IV); and
- Light-UAS.2511 for Medium Risk (SAIL III & IV).

3.17.5 Recommendations for completion

ED-280 –as explicitly stated in its section 3.1– does not address the OSO#05 requirement (applicable to all SAILs) for a design and installation appraisal.

Additionally, it does not address the requirements requesting a strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard as stated in:

- SORA v2.5 OSO#05 Integrity & Assurance for SAIL IV; and
- Light-UAS.2510(a)(3).

It is to be noted that, after ED-280 was published in December 2020:

- EASA suggested EUROCAE to work on an update of ED-280 to cover all safety design related aspects covered in SORA for the 'specific' category (specifically for the Low (L) and Medium (M) robustness levels) and taking into account the SC Light-UAS (SAIL III & IV).
- Such an update is on-going by EUROCAE WG-105 SG6 (refer to WG-105 TOR – September 2022) covering, in particular, the points mentioned in the second paragraph of this section.
- If such an update is published within the timeframe of the SHEPHERD project, this assessment could then be revised.

ASTM F3309/F3309M-21 & ED-279 & ED-280 wrap-up

Introduction

Following the technical assessment of ASTM F3309/F3309M-21, ED-279, and ED-280 conducted by SHEPHERD, this section provides a series of recommendations on how these three standards may be combined to form a more complete means of compliance (MoC) for the following requirements:

- SORA v2.5 OSO#05, SAIL III to VI;
- SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8);
- EASA SC Light-UAS – Medium & High Risk provisions:
    - Light-UAS.2400(c);
    - Light-UAS.2510;
    - Light-UAS.2511(a); and
    - Light-UAS.2511(b)(1)&(2).

The correlation between the safety analyses requested for compliance is provided in the ED-280 assessment summary.

Recommendations

Based upon the conclusions of the respective assessments, the relevant recommendations are summarised in the following table:

Requirement	Compliance activity	Relevant standard	Remarks
– SORA v2.5 OSO#5, SAIL III to VI; – Light-UAS.2400(c) and Light UAS.2510(a)(1)&(a)(2) – Medium Risk (SAIL III & IV); and – Light-UAS.2400(c) and Light-UAS.2510(a)(1)&(a)(2)&(a)(3) – High Risk (SAIL V & VI).	Functional Hazard Assessment	ED-279	
– SORA v2.5 OSO#5, SAIL III & IV, except for the requirements requesting a strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard; – SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8) Criterion #1 – Low (L), Medium (M) & High (H) and Criterion #4 – Medium (M) & High (H); – Light-UAS.2400(c) – Medium Risk (SAIL III & IV); – and Light UAS.2510(a)(1)&(a)(2)&(b) – Medium Risk (SAIL III & IV); and – Light-UAS.2511(b)(1)&(b)(2)– Medium Risk (SAIL III & IV).	Safety Analysis	ED-280	ED-279 is referred to in ED-280
– SORA v2.5 OSO#5, SAIL III to VI; – SORA v2.5 Annex E section 4 requirements for the containment of the operation (Step #8) – Light-UAS.2400(c) – Medium & High Risk (SAIL III to VI); – and Light UAS.2510 – Medium & High Risk (SAIL III to VI); and – Light-UAS.2511(a) – Medium & High Risk (SAIL III to VI); and – Light-UAS.2511(b)(1)&(b)(2) – Medium & High Risk (SAIL III to VI).	Design / Installation Appraisal and Safety Analysis	ASTM F3309/F3309M-21: – Section 4.4.4 for the design appraisal; – Section 4.4.2 for the installation appraisal – Section 4.6 for the common mode failures analysis, when credit is taken for the independence between failures	After the completion of the recommended tailoring, once and if established, F3309/F3309M-21 could be used as a complement or alternative to above standard, in particular for High Risk

3.18 ED-282

3.18.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ED-282. Minimum Operational Performance Standard for UAS E-Reporting* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- U-space IR (EU) 2021/664 Article 8 requirements on network identification service and its associated set of AMC & GM as published by EASA on 20th December, 2022.

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ED-282 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.18.2 General remarks

While section 1.1.2 of ED-282 states the standard does not address the "*Specification of U-space Services, incl. Network Identification and other related services (e.g., Traffic Information and Conformance Monitoring)*", it focuses on the e-Reporting safety function meant to provide surveillance information:

- generated by a UAS, either from the UA itself or its remote pilot station (RPS);
- at destination of other UAS and/or U-space services.

To that extent, the standard represents the foundation principles for the safe operation of drones by capturing several services (Electronic conspicuity, Remote Identification, V2V DAA type messaging and network identification).

Moreover, since Article 8(4) is only providing background information on the list of authorised users referenced in Article 8(2), the assessment of Article 8(4) is covered through the assessment of Article 8(2).

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.18.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ED-282 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-282			
Requirement	**Related AMC & GM**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
NET-ID Article 8(1)	AMC3(a) & (b) to Article 8(1) – Duration of the flight	Section 1.11.1	It is assumed that the requirement on the UA to be powered on will satisfy the AMC regarding the availability of the service for all the duration of the flight
NET-ID Article 8(2)(b) unique serial number of the UA	N/A	Section 1.11.2.3 Section 3.1.1.2 Appendix H – section H.2	The sections listed are correlated, as first it is described their function (sections 1.11.2.2 & 1.11.2.3) and then their technical details (sections 3.1.1.1 & 3.1.1.2 and Appendix H).
NET-ID Article 8(2)(c) geographical position of the UAS, its altitude above mean sea level and its height above the surface or take-off point	GM1 to Article 8(2)(c) – Altitude above mean sea level AMC1 to Article 8(2)(c) – Altitude above mean sea level	Section 1.11.2.2 Section 3.1.1.1 (except for altitude AMSL) Appendix H – section H.1 (except for altitude AMSL)	
NET-ID Article 8(2)(d) route course measured clockwise from true north and the ground speed of the UAS	N/A	Section 1.11.2.2 Section 3.1.1.1 Appendix H – section H.1	

NET-ID Article 8(2)(f) emergency status of the UA	GM1 to Article 8(2)(f) - UAS emergency status	Section 1.11.2.2 Section 3.1.1.2 Appendix H – section H.2	
NET-ID Article 8(2)(g) time at which the messages were generated	N/A	Section 3.1.1.1 Appendix H – section H.1	
NET-ID Article 8(3)	GM1 to Article 8(3) – Update frequency	Section 3.1.2.1	N/A

3.18.4 Non-recommended sections

This subsection provides the list of elements of ED-282 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ED-282			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement**	**Required tailoring / complementing**
Section 3.1.2.1 – State Data Transmit Rate	Data Transmit Rates Requirements	AMC2 to Article 8(1) – Continuous processing	It does not address the response time for distributing data from the USSP, but only for the data received from the UA.
Section 3.1.2.2 – Identification and Status Data Transmit Rate	Data Transmit Rates Requirements	AMC2 to Article 8(1) – Continuous processing	It does not address the response time for distributing data from the USSP, but only for the data received from the UA.
Section 3.1.3.2 – Periodicity	Data Quality Requirements	AMC2 to Article 8(1) – Continuous processing	It does not address the response time for distributing data from the USSP, but only for the data received from the UA.
Section 3.1.3.4 – Continuity	Data Quality Requirements	AMC2 to Article 8(1) – Continuous processing	It does not address the response time for distributing data from the USSP, but only for the data received from the UA.
Section 1.10.3.6 – E-Reporting Data Distribution	High Level Functional Architecture	AMC4 to Article 8(1) – Data Exchange interface AMC1 to Article 8(2) – Access	Further work has to be done regarding the peculiarities of the two data exchange interfaces mentioned in the standard and in the two AMC
Section 1.11.1 – Operational requirements	Operational goals	AMC1 to Article 8(1) – Provision of Aggregated UAS Remote Identification	It does not address the distribution data from the USSP, but only for the data received from the UA

Appendix A – A.2.3 Protocols and formats	OSED	AMC4 to Article 8(1) – Data Exchange interface	Further work has to be done regarding the peculiarities of the data exchange interfaces mentioned in the standard and in the AMC
Section 3.1.1.1 – State Data Elements	Data Encoding Requirements	AMC1 to Article 8(2)(c) – Altitude above mean sea level	The standard requirement is referring to the information from the UA, i.e. it does not mention the conversion process to be used by the USSPs, to convert from AGL to AMSL as mentioned in the AMC. It leaves the decision about whether UAS should have both pressure and GNSS open to implementation by competent authorities.
Section 3.1.2.2 – Identification and Status Data Transmit Rate	Data Transmit Rates Requirements	GM1 to Article 8(3) – Update frequency	The standard requirement update rate is every 10 seconds, i.e. more than 3 seconds as defined in the GM.

3.19 ED-301

3.19.1 Assessment rating

ED-301. Guidelines for the use of multi-GNSS solutions for UAS specific category – Low risk operations SAIL I & II is **RECOMMENDED** for showing compliance with **SORA v2.5 OSO#13 at a Low (L) level of robustness** [Low (L) level of integrity and Low (L) level of assurance] when using **GNSS as an external service**.

3.19.2Technical assessment summary

ED-301 can be directly applied by UAS operators and is recommended for showing compliance with SORA v2.5 OSO#13 when using GNSS as an external service for low-risk UAS operations (i.e., **SAIL I & II**) for a Low (L) level of robustness, including **EASA STS-01** and **STS-02**. In particular, it:

- provides a step-by-step guide on **how to make use of GNSS in UAS operations in a low-risk scenario**, including recommendations on **how to identify and cope with external GNSS external service performance degradation / deterioration**;
- provides useful recommendations to UAS operators on **how to address the main threats –both internal & external– and vulnerabilities associated with the external GNSS service; their impact on GNSS performance**; and various **possible detection and mitigation measures & actions**;
- proposes a procedure for UAS operators to **determine the GNSS performance level needed** for a given operation and provides some **reference values**, including the most common situations in which the external GNSS service might be degraded and, therefore, in which the UAS operator is encouraged to use a variety of GNSS tools and services in order to ensure compliance with the required performance level; and
- can be used to gain an **extensive knowledge of the primary GNSS information / service providers**, including GPS (USA), Galileo (Europe), GLONASS (Russia), Beidou (China), and EGNOS (European SBAS).

3.19.3 Summary of ED-301 content

3.19.3.1 Scope

The main objective of ED-301, Edition August 2022, is to help UAS operators show compliance with SORA OSO#13 when using GNSS as an external service for low-risk UAS operations (i.e., SAIL I & II) for a Low (L) level of robustness (for both integrity and assurance).

3.19.3.2 Main assumptions

- GNSS includes GPS (USA), Galileo (Europe), GLONASS (Russia), Beidou (China), and EGNOS (European SBAS). Except for EGNOS, other augmentation systems, such as RTK or PPP, are not covered by ED-301;
- **The UA is equipped with at least one GNSS-enabled receiver**, which should be able to perform as required for the intended operation;
- There is **a comprehensive service associated to all the possible GNSS primary sources of information**, ideally described through a specific document (e.g., Service Definition Document (SDD) for Galileo and EGNOS); and

- Particular service facilitators and providers can be identified behind these services, which can provide detailed information and collaborate with relevant stakeholders in optimising GNSS use.

3.19.3.3 Relevant content

Section(s)	Page	Content
2.3.2	15 – 18	Analysis of the relationship between SORA and GNSS through OSO#13 and high-level overview of the steps required to comply with the requirements for Low (L), Medium (M), and High (H) levels of robustness for both integrity and assurance.
Chapter 3 presents a procedure for the definition of the use of GNSS in UAS operations.		
3.1	19 – 24	Guidelines in the form of a checklist on how to make use of multi-GNSS in UAS operations in a low-risk scenario.
3.2	24 – 25	Recommendations to cope with external GNSS service performance degradation (i.e., detection of potential GNSS service performance degradation and actions to mitigate it).
3.3	26 – 29	Insight on how to comply with the criteria of OSO#13 in low-risk operations (low robustness) as regards the potential deterioration / degradation of the GNSS external services supporting the UAS operations through Table 3-2 (integrity) and Table 3-3 (assurance).
Chapter 4 illustrates the application of GNSS to EASA's STS-01 and STS-02, respectively, with a special focus on 1) the definition of the operational volume, considering the impact that the use of GNSS has on its shape and size; and 2) OSO#13, which specifically addresses GNSS as an external service.		
4.1.1.3 & 4.2.1.3	33 – 34 & 43 – 46	Operational volume definition, which includes the computation and/or assumption of the total system error (TSE), the flight technical error (FTE), and the navigation system error (NSE), both for the vertical and horizontal dimensions.
4.1.2 & 4.2.2	34 – 37 & 46 – 47	Mechanisms to detect potential external GNSS service performance degradation (e.g., use of a multi-frequency solution, use of a multi-constellation solution, use of tools providing an estimation of the number of satellites available for a certain location and time (i.e., GNSS planning tools), GNSS augmentation services, etc.).
4.1.3 & 4.2.3	38 – 40 & 48 – 50	OSO#13 integrity and assurance levels, which includes relevant position performance figures (i.e., horizontal and vertical position accuracy (2σ or 95%) for Galileo OS, EGNOS OS, and GPS SPS).
Appendix II assesses in detail the primary GNSS information / service providers.		
II.1	55 – 60	Detailed assessment of the global open and free satellite-based navigation systems (i.e., Galileo OS, GPS SPS, GLONASS SPS, and Beidou OS), including the following relevant information: ● intended function(s) / purpose(s); ● frequency bands;

		• timing and frequency accuracies; • other OS / SPS performance requirements; and • relevant official documents (e.g., SDD, ICD / IS, PSS, etc.) and other technical documentation, as well as sources of real-time information.
II.2	60 – 62	Description of the two planned global high-accuracy and open navigation message authentication services, being both of them provided by Galileo (i.e., Galileo High Accuracy Service (HAS) and Galileo OS Navigation Message Authentication (OS-NMA)).
II.3	62	High-level explanation of the global open and free navigation for safety of life (SoL) operations: advanced receiver autonomous integrity monitoring (ARAIM), which refers to any implementation of GNSS-receiver-based ABAS other than GPS receiver autonomous integrity monitoring (RAIM), including single or dual frequency and single or multiple constellation modes.
II.4	62 – 67	Illustration of the European satellite-based navigation augmentation services, EGNOS, aimed at complementing (only for users in Europe) the existing satellite navigation services provided by the US GPS.
Appendix III proposes a procedure to determine the GNSS performance level needed for a given operation and provides some reference values, including the most common situations in which the external GNSS service might be degraded and, therefore, in which a variety of GNSS tools and services are needed in order to ensure compliance with the required performance level.		
III.1	68	Definition of the relevant qualitative and quantitative GNSS performance parameters (i.e., positioning accuracy with a 95% of confidence level, availability, and continuity).
III.2	68 – 72	Description of how the GNSS performance impacts the dimensioning of the operational volume with a focus on the definition and computation of the total system error (TSE), which includes three error sources, i.e., the navigation system error (NSE), the flight technical error (FTE), and the path definition error (PDE).
III.3	72 – 79	Additional recommendations about the main: • threats, internal (e.g., GNSS potential disruption) and external (e.g., geographic location, environmental, human activity, obstacles) to the GNSS system; • impact on GNSS performance (e.g., accuracy); • mitigation measures (e.g., multi-frequency, specific frequency band, multi-constellation available, GNSS augmentation, etc.); and • detection actions (e.g., GNSS online planning tools, GNSS UAS behaviour, GNSS alternative receivers , GNSS SPS status information, etc.) associated with the external GNSS service vulnerabilities (e.g., low satellite visibility / poor satellite geometry, strong atmospheric effect, strong multipath, strong signal degradation).

3.20 ISO 16803-1:2020

3.20.1 Assessment rating

ISO 16803-1:2020. Space – Use of GNSS-based positioning for road intelligent transport system (ITS) – Part 1: Definitions and system engineering procedures for the establishment and assessment of performances is **NOT RECOMMENDED** for showing compliance with **SORA v2.5 OSO#13** when using **GNSS as an external service**.

3.20.2 Technical assessment summary

ISO 16803-1:2020 cannot be directly implemented by UAS operators and, therefore, is not recommended for showing compliance with SORA v2.5 OSO#13 when using GNSS as an external service.

Being specifically developed for its application to the Road ITS domain, ISO 16803-1:2020 targets mainly Road ITS application(s) developers, as it proposes a method called *Sensitivity analysis*[1] to assess the performance of open-loop *Road ITS*[2] applications when they are fed with outputs of a given *GNSS-based positioning terminal*[3] (*GBPT*). Such Sensitivity analysis methodology is, however, not relevant for the assessment of the performance of the GBPT itself.

Keeping the above in mind, ISO 16803-1:2020 may still be used to gain a better understanding of a GNSS-based positioning system, as it:

- describes the general architecture of a GBPT;
- addresses the identification and definition of meaningful positioning performance features and metrics for GBPT; and
- defines various relevant concepts to be considered when specifying an Operational scenario[4] and provides a method to finely compare two environments regarding their effects on GNSS positioning performance.

3.20.3 Summary of ISO 16803-1:2020 content

3.20.3.1 Scope

ISO 16803-1:2020:

- describes the generic architecture of a Road ITS system based on GNSS;

[1] *Sensitivity analysis* is defined as the method to assess the performance of a Road ITS application or a complete Road ITS System, consisting in injecting a high number of simulated degraded PVT data obtained by adding, to a reference trajectory, PVT error models representing the real errors observed during dedicated field tests.

[2] *Intelligent Transport System(s) (ITS)* is defined as the system(s) applying the information, communication, and positioning technologies to the transport domain.

[3] *Positioning terminal* is defined as the equipment (unit) carried by a vehicle or a person delivering a position solution (directly interfaced) to the position data user.

[4] *Operational scenario* is defined as the description of the conditions in which the GNSS-based Road ITS System is operating and particularly affecting the GNSS-based positioning terminal.

- addresses the final stage of the performance management approach, which corresponds to the assessment of the performance of the whole Road ITS system equipped with a given positioning system by means of the sensitivity analysis methodology;
- addresses the identification and definition of the positioning performance features and metrics required for the positioning system assessment; and
- defines the various concepts to be considered when specifying (definition + characterisation) an operational scenario and provides a method to finely compare two environments with respect to their effects on GNSS positioning performance.

It does not address the performance metrics to be used to define the Road ITS system performance requirements, highly dependent on the use case(s); the performance requirements of the various kinds of Road ITS systems; or the tests necessary to assess the positioning system performances.

3.20.3.2 Main assumptions

The interface between the two components of a positioning-based Road ITS system (i.e., positioning system and Road ITS application) is assumed to be the PVT (Position - Velocity - Time) information, together with some auxiliary information (e.g., integrity information).

3.20.3.3 Baseline

- To meet the minimum GNSS positioning performance requirements that satisfy a Road ITS system's final requirements at the user level, the system includes a processing module called Road ITS application which uses the outputs (PVT) of a positioning system to provide the service with a given *End-to-end* (E2E) performance.

  Consequently, this latter depends on the quality of the positioning outputs, which are highly variable on the operational conditions of the system, but also on the performance of the Road ITS application itself.
- There is no standard that supports the certification as regards the positioning E2E performance of Road ITS systems.
- The performance management approach proposed is based on a classical system engineering approach and is a support for engineers facing the problem of handling the performances of a Positioning-based Road ITS system.
- The logic of the overall performance management approach is depicted in Figure 3 (p. 6) and the generic performance allocation process is illustrated in Figure 4 (p. 7).
- The performance requirements of the Road ITS application are the same ones as the system's E2E performance requirements but expressed under the condition that the positioning system respects certain performance requirements.
- Due to the specificities of GNSS performances, which are due to be defined statistically and which are highly dependent on the operational conditions, margins should be planned in the performance allocations in order to allow the system to meets its performance requirements, even when, under certain conditions, one of its components does not strictly meets its own requirements - this is the objective of the sensitivity analysis.

3.20.3.4 Relevant content

The following table indicates the content of ISO 16803-1:2020 relevant for gaining a better understanding of the general architecture of a GNSS-based positioning system.

Section(s)	Page	Content
Section 4 describes the generic architecture of a GNSS-based Road ITS System.		
4.1	16	Generic architecture of a GNSS-based Road ITS system consisting of a positioning system and a Road ITS application that use positioning data to provide a service to the user (e.g., navigation aid, tracking, presence detection, etc.).
4.2.1	16 – 17	Positioning system's components and outputs (i.e., on the one hand, the *GNSS-based Positioning Terminal* (GBPT) components and, on the other hand, the PVT data).
4.2.2	17	The Road ITS application sub-modules (i.e., technical & business sub-modules).
Section 5 defines the positioning metrics, which are used for the characterisation of the PVT performances as the basis for establishing requirements and for evaluation & validation purposes.		
5.2	18 – 19	Detailed definition of the positioning terminal outputs (i.e., position, velocity, speed, heading, pitch, roll, protection levels, and timestamp).
5.3	20	Characteristics of the positioning terminal outputs that are relevant for the identification of the performance features (i.e., position error, velocity error, speed error, attitude errors, protection levels, timestamp, and time of output).
5.4	20 – 21	Performance features to be described (i.e., accuracy, integrity, availability, continuity, and timing performance).
5.5	21 – 33	Relevant positioning performance metrics in accordance with the previous performance features (Tables 1 - 5)
5.6	34 – 36	Example on how to state unambiguous and verifiable Positioning Terminal performance requirements based on the previously defined metrics.
Section 6 defines the concept of *operational scenario* and provides a classification and characterisation of GNSS environments.		
6.1.2	37	Set-up conditions of the GBPT and, in particular, of the GNSS receiver antenna.
6.1.3	37	Trajectory of the mobile vehicle, in particular of the antenna
6.1.4	37 – 38	GNSS environmental conditions, including the GNSS satellite constellations geometry, latitude, semi-static surrounding obstacles geometry (geometrical environment), dynamic surrounding

		obstacles geometry, surrounding obstacles physical properties, general electromagnetic environment, weather conditions, and ionospheric conditions).
6.2.1	39	GNSS environment characterisation process: 1) coarse absolute characterisation and 2) fine comparison of every environment (Figure 9).
6.2.2	39 – 40	High-level classification of GNSS environments (i.e., flat rural or clear sky; three-lined rural; mountainous; peri-urban; urban; and modern urban canyon).
6.2.3	40 – 41	Fine characterisation of the GNSS environment through the description of the characterisation procedure, the Benchmark GNSS receiver, the metrics, and the comparison test procedure to be used.
Section 7 focuses on the Sensitivity analysis.		
7.1	42	General definition of the Sensitivity analysis method.
7.2.1	42 – 45	Methodology main steps: 1) Definition of the operational scenario and the test protocol; 2) GBTP field tests execution; 3) PVT error model identification; 4) Generation of degraded trajectories; 5) E2E performance assessment; and 6) Safety margin analysis. Figure 10 illustrates the Sensitivity analysis general principle. Figure 11 illustrates the particular case of integrity failure (rare event).
7.2.2	45 – 46	Definition of the operational scenario and the test protocol, in particular the design of the tests using degraded simulated PVTV.
7.2.3	46 – 47	Description of the execution of the GBPT field tests that are aimed at building the PVT error models representative of the behaviour of the GBPT in the chosen environment(s) in order to be able to assess the performances of the whole system by simulation.
7.2.4	47	Correct PVT error model identification following the establishment of the error database.
7.2.5	47	Generation of simulated degraded trajectories by means of the Degraded PVT generator
7.2.6	47	E2E performances assessment.
7.2.7	47	Estimation of the safety margins and their analysis.
Section 8 focuses on the PVT error models.		
8.1	48	Principles and utility of PVT error models for the application of the sensitivity analysis method.
8.2	49	Different types of error models.

8.3	49 – 50	Conformity assessment of the PVT error models, with the illustration of the general procedure in Figure 13.
Annex A provides background information to support the definition of positioning performance metrics provided in Section 5 and an example of how performance requirements can be established based on those metrics.		
A.2.2	51 – 52	Accuracy metrics.
A.2.3	52 – 54	Integrity metrics, with sample definitions for ‘Horizontal position integrity risk’ and ‘Horizontal position misleading information rate’ in A.2.3.2, and ‘Horizontal position protection level performance’ in A.2.3.3.
A.2.4	54 – 55	Availability metrics, with sample definition for ‘Position Availability (T)’.
A.2.5	55 – 56	Timing performance metrics with sample definitions for ‘Output latency stability’, ‘Output rate stability’, and ‘Warm start TTFF’.

3.21 ISO 16803-2:2020

3.21.1 Assessment rating

ISO 16803-2:2020. Space – Use of GNSS-based positioning for road intelligent transport system (ITS) – Part 2: Assessment of basic performances of GNSS-based positioning terminals is **NOT RECOMMENDED** for showing compliance with **SORA v2.5 OSO#13** when using **GNSS as an external service**.

3.21.2 Technical assessment summary

ISO 16803-2:2020 cannot be directly implemented by UAS operators and, therefore, is not recommended for showing compliance with SORA v2.5 OSO#13 when using GNSS as an external service.

Being specifically developed for its application to the Road ITS[5] domain, ISO 16803-2:2020 targets mainly the generalist radio-frequency (RF) test laboratories that will be in charge of assessing the performances of *GNSS-based positioning terminals* (GBPT) for different applications - it only addresses the replay phase of the "*Record and Replay*" (R&R) tests consisting in replaying in a laboratory environment GNSS Signal-In-Space (SIS) data, along with additional sensor data, that result from field tests under specific operational conditions.

Keeping the above in mind, ISO 16803-2:2020 may still be used to gain a better understanding of the basic performances and behaviours of GBPT, including the mathematical definition of the relevant metrics, and their assessment through the R&R testing approach.

3.21.3 Summary of ISO 16803-2:2020 content

3.21.3.1 Scope

ISO 16803-2:2020:

- proposes testing procedures, based on the replay in the laboratory of real data sets recorded during field tests, assuming no security attack during the test, to assess the basic performances of GNSS-only positioning terminals for a given use-case described by an *Operational scenario*[6]; such tests address the basic performances features - availability, continuity, accuracy, and integrity (ACAI) - of the PVT information, as well as the time-to-first-fix (TTFF) timing performance feature;
- addresses only the 'Replay' part of the 'Record and Replay' (R&R) test scenario data set; it does not address the 'Record' part, although it describes –for information– the whole R&R process; and
- does not set minimum performance requirements for any Road ITS application.

3.21.3.2 Main assumptions

- In accordance with the generic functional architecture of a Road ITS system based on GNSS, two main subsystems are considered: 1) the positioning system (i.e., the GNSS-based

[5] *Intelligent Transport System(s) (ITS)* is defined as the system(s) applying the information, communication, and positioning technologies to the transport domain.
[6] *Operational scenario* is defined as the description of the conditions in which the GNSS-based Road ITS System is operating and particularly affecting the GNSS-based positioning terminal.

positioning terminal (GBPT) + external data) and 2) the Road ITS application processing the position quantities output by the terminal to deliver the final service to the user.

- The performances of the application cannot be assessed independently from the GBPT and the adequacy of the GBPT's performances to the End-to-End (E2E) performance of the system cannot be assessed independently from the application.

3.21.3.3 Baseline

- The 'Record and Replay' (R&R) technique combines realism, repeatability, and cost-effectiveness; it covers all constellations and all frequencies by allowing the recording of lower L-Bands and upper L-Bands of GNSS SIS.
- The R&R technique starts on the field, by recording the test data collection according to an agreed scenario; this step guarantees a high-fidelity digitalisation of numerous parameters, in particular the capture of radio signals issued from the worldwide infrastructure (GNSS) in a realistic local environment of propagation. It ends in the laboratory to replay as many times as required for the same scenario, using identical radio signal inputs and, thus, the same environmental conditions of reception.
- The R&R technique offers:
    - a better representativeness of reality, as it comes from real situations, but less flexibility of test situations;
    - better meteorological features, since repeatability can be reached;
    - money saving, since the setup of the test bench for recording is similar to one field test, but the setup of the test bench for replaying is largely less expensive and enables to test a multitude of receivers with less additional cost; and
    - capabilities like copies and licensing, cut and paste, browse, etc., as the interface between the record and replay (R&R) phases is a repository of files.
- Since the record phase needs recognised skills and experience in GNSS metrology, only GNSS-specialised laboratories that are ISO/IEC 17025 homologated and accredited for that job by a certification authority can perform this work.

3.21.3.4 Relevant content

The following table indicates the content of ISO 16803-2:2020 relevant for gaining a better understanding of the basic performances and behaviours of a GBPT, including the mathematical definition of the relevant metrics, and their assessment through the R&R testing approach.

Section(s)	Page	Content
Section 4 describes the complete R&R process.		
4.1	11 – 13	Definition of the general strategy for the R&R technique.
4.2	13 – 20	Construction of the operational scenarios and configuration of the tests.
4.3	20 – 21	Description of the test facilities / equipment needed both for the record and replay phases

4.4	21 – 23	Description of the record phase, in particular how to elaborate data sets of the test scenarios, through the test plan establishment, test bench preparation & good functioning verification, field test execution, and data control & archiving.
4.5	24	the replay phase, in particular the assessment of the device under test (DUT) performances.
Section 5 provides the mathematical definitions of the metrics used to evaluate the GBPT performance.		
5.1	24 – 25	General considerations.
5.2	25	Basic notations.
5.3	25 – 26	Time interpolation procedure.
5.4	26 – 27	Mathematical definition of the accuracy metrics.
5.5	27 – 32	Mathematical definition of the availability & continuity metrics.
5.6	32 – 33	Mathematical definition of the integrity metrics (protection level performance & misleading information rate).
5.7	34 – 36	Mathematical definition of the timing metrics (timestamp, nominal output latency, nominal output rate, output latency stability, output rate stability, and time-to-first-fix).
Section 6 describes the replay phase, in particular the procedure to assess the DUT performances.		
6.2	37 – 38	Check of the content of the test scenario (i.e., minimum set of data).
6.3	38	Set-up of the replay test-bench in the case the GBPT has an external interface for its antenna (Figure 11) or it does not (Figure 12).
6.4	39	Validation of the data processing HW & SW by the RF test lab (SW & system validation).
6.5	39 – 42	Replay of data.
6.6	42	Computation of the ACAI performances.
6.7	42 – 47	Computation of the TTFF performances.
6.8	47	Establishment of the final test report.
Section 7 (47 - 50) provides the definition of the validation procedures through 1) the definition of the validation with the verification of the metrics computation SW and the verification of the end-to-end test process (SW & HW); and 2) the pass/fail criteria for the verification of the test procedures for the different types of metrics.		
Section 8 (50 - 57) provides a template for the test synthesis report.		
Annex B provides detailed criteria for the testing strategy, in particular the trade-off between metrological quality and cost efficiency.		

B.2	62 – 63	Metrological quality (i.e., reproducibility, representativeness, and reliability).
B.3	63 – 64	Cost efficiency (i.e., cost of test benches and cost of the test operations).
B.4	64	Sharing of responsibility.
B.5	64 – 65	Scenario-management authority.
Annex C gives some elements that help to appreciate the expected technology to be deployed in the context of the standard.		
C.2	66 – 67	Experimentation considerations.
C.3	68 – 74	Justification of the equipment recommended.
C.5	76	Quality of the reference trajectory.
C.6	77 – 78	Availability, regularity of the DUT's outputs for the metrics computations.
Annex D (79 - 83) covers the R&R procedure when applied to hybridised GBPT.		
Annex E (84 - 86) provides relevant considerations on coordinate systems, reference frames, and projections.		

3.22 ISO 23665:2022

3.22.1 Introduction

The objective of this section is to present the outcome of the preliminary high-level assessment and subsequent detailed technical assessment of *ISO 23665:2022. Unmanned Aircraft Systems – Training for Personnel Involved in UAS Operations* conducted in accordance with the criteria and methodology developed by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA v2.5 OSOs:
  - OSO#07 Assurance, SAIL I to VI;
  - OSOs#08 Criterion#3 Assurance, SAIL II to VI;
  - OSOs#09+, SAIL I to VI; and
  - OSO#19 Criterion #2, SAIL III to VI.
- EASA's remote crew training-related requirements:
  - AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);
  - AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e); and
  - AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e).

It identifies and substantiates the list of recommended sections, subsections, paragraphs, or combination thereof of ISO 23665:2022 that have been deemed suitable and, hence, may be used as a basis for a means of compliance (MoC) for the requirements or a part thereof. In the same manner, it also lists and provides clear justification for the elements of the standard that have been found not technically adequate and, thus, need to be tailored and/or complemented before being proposed as a MoC.

3.22.2 General remarks

ISO 23665:2022 provides specifications for training organisations and theoretical and practical training of remote pilots for VLOS operations only.

This standard does not address any of the following aforementioned requirements:

- OSO#07 Criterion#1 Assurance, SAIL I to VI;
- OSOs#08+ Criterion#3 Assurance, SAIL II to VI;
- OSO#19 Criterion#2 Integrity, SAIL III to VI; and
- AMC3 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e);

For further details on the rationale for the sections that have been considered as 'N/A' being too high-level requirements or similar to the requirements, as well as the rationale for the recommended sections, refer to the detailed technical assessment here.

3.22.3 Recommended sections

This subsection provides the list of recommended sections, subsections, paragraphs, or combination thereof of ISO 23665:2022 that may be used as a basis for a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ISO 23665:2022			
Requirement	**Related SAIL Integrity / assurance**	**Recommended section(s), subsection(s), paragraph(s), or combination thereof**	**Additional relevant information**
OSOs#09+	SAIL V & VI Assurance	Section 5.3	It covers the display of the certificate accrediting the training organisation as a competent third party
OSOs#09+	SAIL I to VI Assurance	Section 5.6	It lists relevant pieces of information to be provided to trainees in the case where training is provided by an external training organisation. Some elements can be also applied in the case where training is provided directly by the UAS operator.
OSOs#09+	SAIL I to VI Assurance	Section 8	The need for training for remote crew is provided. This section addresses the proof of competency-based, theoretical and practical training, but does not provide any information about the availability of the training syllabus.
OSO#19 Criterion #2	SAIL VI Assurance	Section 5.3	It covers the display of the certificate accrediting the training organisation as a competent third party.
OSO#19 Criterion #2	SAIL III to VI Assurance	Section 5.6	It lists relevant pieces of information to be provided to trainees in the case where training is provided by an external training organisation. Some elements can be also applied in the case where training is provided directly by the UAS operator.

OSO#19 Criterion #2	SAIL III to VI Assurance	Section 8	The need for training for remote crew is provided. This section addresses the proof of competency-based, theoretical and practical training, but does not provide any information about the availability of the training syllabus.
OSOs#09+	SAIL I to VI Integrity	Annex A – VLOS UAS pilot course	This section addresses theoretical and practical skills for UAS operations in VLOS only: UAS Regulation, airspace operating principles, airmanship and aviation safety, human performance limitations, meteorology, navigation/charts, UAS, operating procedures. The use of external services is not addressed: there are no specifications about how the remote crew is trained to use the service as intended.
OSOs#09+	SAIL I to IV Assurance	Annex A – VLOS UAS pilot course	This section addresses theoretical and practical skills for UAS operations, in VLOS only, with syllabus available.
OSO#19 Criterion #2	SAIL III to V Assurance	Annex A – VLOS UAS pilot course	This section addresses theoretical and practical skills for UAS operations, in VLOS only, with syllabus available.
AMC1 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	Annex A – Section A.4	This section addresses all the points highlighted in AMC1 for theoretical training, but it is developed only for UAS operations in VLOS. ERP, managing data sources, level of automation of the UAS operation are not fully addressed.
AMC2 UAS.SPEC.050(1)(d) & UAS.SPEC.050(1)(e)	N/A	Annex A – Section A.5	Only general practical/management skills (pre-, in-, and post-flight procedures) and flight operation skills are addressed, while some relevant aspects, such as flight under abnormal conditions, contingency and emergency procedures, etc., are missing.

3.22.4 Non-recommended sections

This subsection provides the list of elements of ISO 23665:2022 that need to be tailored and/or complemented before being proposed as a MoC for the requirements or a part thereof as identified in the detailed technical assessment, which can be accessed here.

ISO 23665:2022			
Section, subsection, or paragraph to be tailored / complemented	**Title / subject**	**Requirement and SAIL**	**Required tailoring / complementing**
Annex A – Section A.4.13.5(1) & (2)	Maintenance of systems	OSO#07 Criterion#2 Assurance SAIL I to VI	Section A.4.13.5 does not address the periodic checks aimed at ensuring that the UAS conforms to the configuration / data approved in the operational authorisation. The UAS might be in fully safe flying condition (as currently covered by the standard), yet does not conform to the approved operation.

3.23 RTCA DO-365A

3.23.1 Introduction

The objective of this document is to present the outcome of the assessment of *RTCA DO-365A. Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems – Phase 1* conducted by SHEPHERD to evaluate the standard's suitability in fulfilling the following requirements:

- SORA Annex D TMPR BVLOS ARC-d: "*A system meeting RTCA SC-228 or EUROCAE WG105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements*".

3.23.2 General remarks

Considering the wording of SORA Annex D TMPR BVLOS ARC-d requirements, one could state that a system meeting RTCA DO-365A requirements automatically meets the SORA TMPR BVLOS ARC-d requirements since the standard was developed by RTCA SC-228.

That said, one needs to recognise that there is a wide variety of DAA standards developed over time by RTCA SC-228 and/or EUROCAE WG-105 committees which addresses different Operational Services and Environment Definition (OSED) and, hence, DO-365A may not be the adequate DAA standard to be followed by all UAS operators willing to demonstrate compliance with SORA Annex D TMPR BVLOS ARC-d requirements and it may be necessary in the near future to revise the SORA Annex D TMPR BVLOS ARC-d requirements.

A mapping of existing DAA standards was not yet available to the general public and the SHEPHERD consortium, in agreement with EASA, took the responsibility to provide such mapping and indicate key elements for each of the DAA standards, including:

- the class of aircraft (MALE, T-UAV, Light-UAS, CS-25, CS-23);
- the platform applicability (manned and/or unmanned);
- the type of intruders (cooperative and/or non-cooperative);
- the EU/US/Global applicability; and
- the type of document (OSED, MOPS, MASPS, etc).

The resulting mapping can be found here.

3.23.3 Recommended sections

As indicated in the previous section, RTCA DO-365A fully meets the SORA TMPR BVLOS ARC-d requirements.

Nevertheless, it is recommended that UAS operators verify that the DO-365A OSED (contained in Annex of DO-365A) matches the intended concept of operations. In particular, the standard focuses on DAA systems used in aircraft transiting and performing extended operations in Class D, E, and G airspace along with transiting Class B and C airspace. It includes equipment to enable UAS operations near Terminal Areas during approach and departure in Class C, D, E, and G airspace, and off airport locations, but not operating in the visual traffic pattern or on the surface. It does not apply to small Unmanned Aircraft Systems (UAS) (under 55 pounds (lbs)) operating in low level environments (below 400 ft) or other segmented areas.

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