Joint Authorities for Rulemaking on Unmanned Systems

JARUS guidelines on SORA

Annex E

Integrity and assurance levels for the Operational Safety Objectives (OSO)

DOCUMENT IDENTIFIER : JAR-DEL-SRM-SORA-E-2.5

Edition Number	**2.5**
Edition Date	**13.05.2024**
Status	**Release**
Intended for	**Publication**
Category	**Guidelines**
WG	**SRM**

DOCUMENT CHARACTERISTICS

TITLE		
Specific Operations Risk Assessment (SORA) Annex E		
	Publications Reference:	JAR_doc_28
	ID Number:	
Document Identifier	**Edition Number:**	2.5
JAR-DEL-SRM-SORA-E-2.5	**Edition Date:**	13.05.2024

Abstract
This documents describes the Operational Safety Objectives and the containment requirements set by SORA.

Keywords
SORA, SAIL, Specific, Risk, Operational Safety Objectives, Containment, Integrity, Assurance

Contact Person(s)	**Tel**	**Unit**
Jörg Dittrich – DLR / Germany Leader Work Group Safety Risk Management		WG-SRM

STATUS, AUDIENCE AND ACCESSIBILITY					
Status		**Intended for**		**Accessible via**	
Working Draft	☐	General Public	☑	Intranet	☐
Final	☑	JARUS members	☐	Extranet	☐
Proposed Issue	☐	Restricted	☐	Internet (http://jarus-rpas.org)	☑
Released Issue	☐	Internal/External consultation ☐			

DOCUMENT APPROVAL

The following table identifies the process successively approving the present issue of this document before public publication.

PROCESS	NAME AND SIGNATURE WG leader	DATE
WG	Lorenzo Murzilli	27.10.2021
Internal Consultation	Lorenzo Murzilli	27.10.2021
External Consultation	Lorenzo Murzilli	08.11.2022
Publication	Jörg Dittrich	13.05.2024

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	REASON FOR CHANGE	PAGES / SECTIONS AFFECTED
1.0	29.01.2018	Version for JARUS Internal Consultation	First edition
1.0	31.05.2018	Version for JARUS External Consultation	Re-work of several sections of the document to account for consultation comments. General editing for increased readability.
1.0	30.01.2019	Public release	Re-work of several sections of the document to account for consultation comments. General editing for increased readability.
2.5	27.10.2021	Version for JARUS Internal Consultation	Rework of all sections for clarity and readability. Move of containment requirements from Main Body. Addition of Functional-Test-Based Approach.
2.5	08.11.2022	Version for JARUS External Consultation	Rework of all sections for clarity. Deletion of duplicate OSO and renumbering using roman numbers. Rework of containment requirements.
2.5	13.05.2024	Public release	Reintroduction of the old OSO numbers. Merge of OSO #10 into OSO #05. General editing for improved readability.

DOCUMENT CONTRIBUTORS

WG-SRM Lead	
From December 2022 before December 2022	Jörg Dittrich – DLR / Germany Lorenzo Murzilli – FOCA / Switzerland
Task Force Main Body (including Annexes B, E, I) Co-Leads	
Andreea Perca – FOCA / Switzerland	Tony Nannini – Wing
Annex E Document Lead	
Alexandra Florin – Wing	
Annex E Document Team	
Michel Allouche – Independent Expert	Leonardo Capacci – EASA
Alejandro Del Estal - Rigitech	David Guttierez – UK CAA
Paul McKay – Transport Canada	Tom Putland – CASA / Australia

This document was supported by other members of the responsible Task Force Main Body.

As multiple WG-SRM members have assumed new responsibilities and changed affiliations over the years of document development, all contributors are listed with their affiliation at the time of their last contribution.

CONTENTS

E.1 How to use SORA Annex E

The following table provides the basic principles to consider when using SORA Annex E.

	Principle description	Additional information
#1	Annex E provides Low/Medium/High assessment criteria for the integrity (i.e. safety gain) and assurance (i.e. method of proof) of the Operational Safety Objectives (OSOs) proposed by an applicant.	The identification and implementation of OSOs for a given operation is the responsibility of the applicant. The relationships between the SAIL and the Low/Medium/High level of robustness of an OSO can be found in Step #9 of the SORA Main Body.
#2	Annex E does not cover the Level of Involvement (LoI) of the competent authority. LoI is based on the competent authority's assessment of the applicant's ability to perform the given operation.	JARUS may develop additional recommendations in the future for competent authorities on the Level of Involvement needed to assess Operators' abilities.
#3	When more than one criterion exists for a given level of integrity or assurance in an OSO, all the criteria need to be met at the required integrity/assurance level to satisfy the given OSO.	
#4	"Not required (NR)" cases defined in SORA Main Body Table 14 do not need to be defined in terms of integrity and assurance levels in Annex E.	No robustness level is required for OSOs for which an "NR" level of robustness is defined in SORA Main Body Table 14 "Recommended operational safety objectives (OSO)".
#5	When criteria to assess the level of integrity or assurance of an OSO rely on "standards" not yet available, the OSO needs to be developed in a manner acceptable to the competent authority.	
#6	Annex E intentionally uses non-prescriptive terms (e.g. suitable, reasonably practicable) to provide flexibility to both the applicant and the competent authorities. This does not constrain the applicant in proposing mitigations, nor the competent authority's ability to determine needs on a case-by-case basis.	
#7	This annex in its entirety also applies to single-person organizations.	
#8	Aspects of cyber security and safety are addressed specifically in the SORA Cyber Extension.	
#9	Some of the OSOs refer to the Functional Test Based (FTB) approach which is described in detail in section E.3.	

E.2 OSOs integrity and assurance criteria

OSO #01 – Ensure the Operator is competent and/or proven

TECHNICAL ISSUE WITH THE UAS		LEVEL of INTEGRITY		
		Low (SAIL II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #01 **Ensure the Operator is competent and/or proven**	Criterion	The applicant is knowledgeable of the UAS[1] being used and as a minimum has the following relevant operational procedures[2]: ● checklists, ● maintenance, ● training, ● responsibilities, and associated duties.	Same as Low. In addition, the applicant has an organization appropriate[3] for the intended operation, with at least the following in place: ● a method to continuously evaluate whether the operator is operating according to the terms of the operational authorization and check whether the mitigations proposed as part of the operational authorization are still appropriate; ● occurrence analysis procedures and reporting to the designer in case of design-related in-service events.	The applicant has a safety management system in place in line with ICAO Annex 19 principles.
	Comments	*[1] Including monitoring of any related airworthiness directives or recommendations issued by National Aviation Authorities and designer recommendations (Service Bulletin, Service Information Letter, etc.)* *[2] Operational procedures (checklists, maintenance, training, etc.) can be justified in the context of other applicable OSO.*	*[3] For the purpose of this assessment appropriate should be interpreted as commensurate/proportionate with the size of the organization and the complexity of the operation.*	*N/A*

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #01 **Ensure the Operator is competent and/or proven**	Criterion	The elements delineated in the level of integrity are available.	Prior to the first operation, a competent third party performs an audit of the organization.	The applicant holds an Organizational Operating Certificate or is/has a recognized flight test organization. In addition, a competent third party recurrently verifies the Operator's competence.
	Comments	*N/A*	*Audits should be adapted to the size and scope of the organization and focus on items that can be connected to the applicable OSOs and their robustness depending on the SAIL of the operation. Audits can take the form of desk reviews, if deemed appropriate.*	

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

<table>
<tr><th colspan="2" rowspan="2">TECHNICAL ISSUE WITH THE UAS</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL III)</th><th>Medium
(SAIL IV)</th><th>High
(SAIL V & VI)</th></tr>
<tr><td rowspan="2">OSO #02
UAS manufactured by competent and/or proven entity</td><td>Criterion</td><td>As a minimum, manufacturing procedures cover:
● specification of materials,
● suitability and durability of materials used,
● processes necessary to allow for repeatability in manufacturing and conformity within acceptable tolerances,
● configuration control.</td><td>Same as Low. In addition, manufacturing procedures also cover:
● verification of incoming products, parts, materials, and equipment,
● identification and traceability,
● in-process and final inspections & testing,
● control and calibration of tools,
● handling and storage,
● non-conforming item control.</td><td>Same as Medium. In addition, the manufacturing procedures also cover:
● personnel competence and qualification,
● supplier control.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL III)	**Medium (SAIL IV)**	**High (SAIL V & VI)**
OSO #02 **UAS manufactured by competent and/or proven entity**	Criterion	The declared manufacturing procedures are developed to a standard considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[1].	Same as Low. In addition, evidence is available that each UAS has been manufactured in conformance to its design.	Same as Medium. In addition: ● manufacturing procedures, ● conformity of the UAS to its design and specification are recurrently verified through process or product audit by a competent third party(ies).
	Comments	*[1]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.*	*N/A*	*N/A*

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

TECHNICAL ISSUE WITH THE UAS		LEVEL of INTEGRITY		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #03 **UAS maintained by competent and/or proven entity**	Criterion	• The UAS Operator[1] <u>maintenance instructions</u>[2] and requirements[3] are defined, cover (when applicable) the UAS designer instructions and requirements[4/5], and are adhered to. • The maintenance staff is competent and has received an authorization to carry out UAS maintenance.	Same as Low. In addition: • Preventive/Scheduled maintenance / inspection of each UAS is organized and in accordance with the UAS Operator <u>maintenance programme</u> on the basis of the UAS designer scheduled maintenance requirements[4] and adapted to the specificities of UAS operations. • Upon completion, the maintenance log system is used to record all maintenance conducted on the UAS including releases. A release to service can only be accomplished by a staff member who has received an authorization to release to service for that particular UAS model/family.	Same as Medium. In addition, the maintenance staff works in accordance with a <u>maintenance procedure manual</u> that provides information and procedures relevant to the Operator maintenance facility, records, maintenance instructions, release, tools, material, components, defect deferral.
	Comments	*[1] The maintenance may be performed by an organization other than the Operator (e.g. use of a third party).* *[2] The UAS Operator <u>maintenance instructions</u> are the information establishing how to carry out the needed maintenance/repairs. These instructions are used by the maintenance staff while performing maintenance.* *[3] The UAS Operator <u>maintenance requirements</u> are the needs for maintenance on the UAS, e.g. inspection after hard landing, regular check of lighting system. The UAS Operator ensures these requirements are covered in the UAS maintenance instructions.* *[4] The UAS Operator may just reuse the UAS designer instructions and requirements for maintenance.* *[5] The UAS designer instructions and requirements for maintenance are sometimes referred to as ICA (Instructions for Continuing Airworthiness).*		

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #03 **UAS maintained by competent and/or proven entity**	Criterion #1 (Procedure)	● The UAS Operator maintenance instructions are documented[1]. ● The maintenance conducted on the UAS is recorded in a maintenance log system[2/3]. ● A list of maintenance staff authorized to carry out maintenance is established and kept up to date.	Same as Low. In addition: ● The UAS Operator maintenance programme layout is in accordance with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[4]. ● A list of maintenance staff with authorization to release to service is established and kept up to date.	Same as Medium. In addition, the Operator Maintenance Programme and the maintenance procedures manual are validated by a competent third party.
	Comments	*[1] The UAS Operator may just reuse the UAS designer instructions and requirements for maintenance.* *[2] The objective is to record all the maintenance performed on the aircraft, and why it is performed (defects or malfunctions rectification, modification, scheduled maintenance etc.)* *[3] The maintenance log may be requested for inspection/audit by the approving authority or an authorized representative.*	*[4] 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.*	*N/A*

	Criterion #2 (Training)	A record of all relevant qualifications, experience and/or trainings completed by the maintenance staff is established and kept up to date.	Same as Low. In addition: ● Initial training syllabus and training standard including theoretical/practical elements, duration, etc. is defined and commensurate with the authorization held by the maintenance staff. ● For staff holding an authorization to release to service, the initial training is specific to that particular UAS model/family. ● All maintenance staff have undergone initial training.	Same as Medium. In addition: ● A programme for recurrent training of staff holding an authorization to release to service is established; and ● This programme is validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*

OSO #04 – UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)

(a) In the scope of OSO#04. the UAS components essential to safe operations are those whose failure would significantly impair the capability of the operator to meet the requested target level of safety in terms of loss of control of the operation

(b) Starting at SAIL IV, it is considered that the safety objective associated to the SAIL of one operation (e.g. probability of loss of control of the operation below 10-4/FH for a SAIL IV operation) cannot be achieved without a UAS components essential to safe operations to be designed to an Airworthiness Design Standard (ADS) (unless an FTB-approach is chosen), where the term Airworthiness Design Standard (ADS) refers to the "applicable regulations" (e.g. 14 C.F.R. § 21.17(1)) or "airworthiness specification".

(c) The list of Airworthiness Design Standard (ADS) to be complied with through OSO#04 are not intended to duplicate requirements already covered by other design-related OSOs. While OSO #04 aims at ensuring that the UAS as a whole is designed according to an ADS (for example, the design and construction, structure, and flight performance is part of the ADS, but not other OSOs), other design-related OSOs focus on particular systems/functionalities of the UAS and or technical disciplines (e.g., safety):

- OSOs #05 (System Safety Related)
- OSO #06 (C3)
- OSO #07 (conformity check)
- OSO #13 (external systems)
- OSO #18 (automatic protection of envelope)
- OSO #20 (HMI)
- OSO #23/#24 (adverse environment).

<table>
<tr><th colspan="2" rowspan="2">TECHNICAL ISSUE WITH THE UAS</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL IV)</th><th>Medium
(SAIL V)</th><th>High
(SAIL VI)</th></tr>
<tr><td rowspan="4">OSO #04

UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)</td><td>Criterion</td><td>The UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)[1] considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority to contribute to the overall safety objective of 10-4/FH for the loss of control of the operation.</td><td>The UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)[1] considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority to contribute to the overall safety objective of 10-5/FH for the loss of control of the operation.</td><td>The UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)[1] considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority to contribute to the overall safety objective of 10-6/FH for the loss of control of the operation.</td></tr>
<tr><td>Comments</td><td colspan="3">[1] Examples of Airworthiness Design Standards (ADS) are:
● the EASA Special Condition Light-UAS, or
● the NATO STANAG 4671 - Unmanned Aerial Vehicles Systems Airworthiness Requirements (USAR),
● the NATO STANAG 4703 - Light Unmanned Aircraft Systems Airworthiness Requirements,
● the JARUS Certification Specification for Light Unmanned Rotorcraft Systems (LURS), or
● the JARUS Certification Specification for Light Unmanned Aeroplane Systems (LUAS).
The applicant is free to propose their own Airworthiness Design Standard(s) to the competent authority.
When aspects of an Airworthiness Design Standards (ADS) is covered by an OSO (for instance OSO#05), the OSO requirement takes precedence.</td></tr>
<tr><td>Alternative criterion taking credit for functional test-based methods</td><td>The applicant has evidence of at least 30,000 FTB flight hours meeting one of the set of conditions described either in section E.3(c) or section E.3(d).</td><td colspan="2">N/A[2]</td></tr>
<tr><td>Comments</td><td>N/A</td><td colspan="2">[2] Functional test-based method are not considered feasible for operations with a SAIL V or VI</td></tr>
</table>

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL IV)	**Medium (SAIL V)**	**High (SAIL VI)**
OSO #04 **UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)**	Criterion	The applicant declares[1] that the required level of integrity has been achieved.	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience.	A competent third party validates the claimed level of integrity.
	Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority.*	*[2] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*
	Alternative criterion taking credit for functional test-based methods	The Operator declares[3] that the FTB flying hours have been executed according to principles/standards[4] considered adequate by the competent authority in charge of granting the Operational Authorization.	N/A[5]	
	Comments	*[3] Supporting evidence for this declaration may still be requested by the competent authority.* *[4] For example ASTM F3478-20: "Standard Practice for Development of a Durability and Reliability Flight Demonstration Program for Low Risk Unmanned Aircraft Systems (UAS) under FAA Oversight."*	*[5] Functional test-based method are not considered feasible for operations with a SAIL V or VI*	

OSO #05 – UAS is designed considering system safety and reliability

(a) OSO #05 ensures that the contribution of the UAS or of any external system supporting the operation to the loss of control of the operation inside the operational volume is commensurate to the acceptable level of risk associated with each SAIL. OSO#05 safety objectives are to be considered in conjunction with the containment safety requirements (Step#8 and section E.4 of this Annex) and, when applicable, the ground risk mitigation requirements (Annex B, in particular M2 Criterion # 1 requirements). In combination, these three sets of safety objectives ensure that whatever the SAIL of the operation, the target level of safety is met and no single failure is expected to lead to a catastrophic effect.

(b) Note on SAIL II operations: Some UAS designs may employ novel or complex features which have very limited operational experience. If such features are identified by the competent authority or applicant, the applicant should assure that the equipment, systems, and installations are designed to minimize hazards in the event of a probable failure of the UAS or of any external system supporting the operation. This should be done through a declaration with a simple written justification from the applicant including functional diagrams and a description of how the system functions. UK CAA CAP 722A Volume 2 section 2.4 named "Section 3 – Safety Features of the UAS" may be considered by the applicant to help with this demonstration.

TECHNICAL ISSUE WITH THE UAS		LEVEL of INTEGRITY		
		Low **(SAIL III)**	**Medium** **(SAIL IV)**	**High** **(SAIL V & VI)**
OSO #05 **UAS is designed considering system safety and reliability**	Criterion	The equipment, systems, and installations are designed to minimize[1] hazards[2] in the event of a probable[3] failure of the UAS or of any external system supporting the operation.	Same as Low. In addition, the strategy for detection, alerting and management of any failure or combination thereof, which would lead to a hazard is available.	• Major Failure Conditions are not more frequent than Remote[4]; • Hazardous Failure Conditions are not more frequent than Extremely Remote[4]; • Catastrophic Failure Conditions are not more frequent than Extremely Improbable[4]; • No single failure can lead to a Catastrophic Failure Condition; • 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[5].

	Comments	*[1] The minimization of hazard criterion correlates to the contribution of the UAS and of any external system supporting the operation to the loss of control of the operation rate, thus the SAIL of the operation. As an example, at SAIL III, the contribution of the UAS and of any external system supporting the operation to the loss of control of the operation rate could be 10-4/FH assuming a traditional 10% contribution of the technical aspects to the safety of an operation.* *[2] For the purpose of this assessment, the term "hazard" should be interpreted as a failure condition that relates to major and hazardous (the term "Catastrophic" is intentionally not included since the TLOS is considered met for SAIL I to IV operations with the provision of Note 1 above and, if applicable M2 requirements in Annex B).* *[3] 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 operational life of a UAS".*	*N/A*	*[4] Safety objectives 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.* *[5] 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.*

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL III)	**Medium (SAIL IV)**	**High (SAIL V & VI)**
OSO #05 **UAS is designed considering system safety and reliability**	Criterion	A Functional Hazard Assessment[1/2] and a design and installation appraisal[3] that shows hazards are minimized are available.	Same as Low. In addition: ● Safety assessment are conducted in line with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. ● A strategy for the detection of single failures of concern includes pre-flight checks.	Same as Medium. In addition, safety assessment and development assurance activities are validated by a competent third party.
	Comments	[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.* [2] *UK CAA CAP 722A Volume 2 section 2.4 named "Section 3 – Safety features of the UAS" or Eurocae ED-280 "Guidelines for UAS safety analysis for the specific category (low and medium levels of robustness)" may be considered by the applicant to support compliance with this criterion (FHA).* *For SAIL III and IV, Eurocae ED-280 "Guidelines for UAS safety analysis for the specific category (low and medium levels of robustness)" may be considered*	*For SAIL IV, 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.*	*N/A*

		acceptable by the competent authority to support compliance with this criterion (FHA). [3] *A simple written justification from the operator including functional diagrams and a description of how the system works explaining why the integrity claim is met is an acceptable means of compliance.*		

OSO #06 – C3 link characteristics (e.g., performance, spectrum use) are appropriate for the operation

(a) For the purpose of the SORA and this specific OSO, the term "C3 link" encompasses:

- the Command and Control (C2) link, and
- any communication link required for the safety of the flight.

(b) To correctly assess the integrity of this OSO, the applicant should identify:

1) The C3 links performance requirements necessary for the intended operation.

2) All C3 links, together with their actual performance and Radio Frequency (RF) spectrum usage.

   Note: The specification of performance and RF spectrum for a C2 Link is typically documented by the UAS designer in the UAS manual.

   Note: Main parameters associated with C2 link performance (RLP) and the performance parameters for other communication links (e.g., RCP for communication with ATC) include, but are not limited to the following:

   - Transaction expiration time
   - Availability
   - Continuity
   - Integrity

   Refer to ICAO references for definitions, and to JARUS RPAS "Required C2 Performance" (RLP) concept.

3) The RF spectrum usage requirements for the intended operation (including the need for authorization if required).

   Note*: Usually, countries publish the allocation of RF spectrum bands applicable in their territory. These allocations stem primarily from the International Telecommunication Union (ITU) Radio Regulations (RR). However, the applicant should check their State requirements and request authorization when needed since there may be national differences to spectrum allocations (e.g. national sub-division of ITU allocations). Some aeronautical bands (e.g., AM(R)S, AMS(R)S 5030-5091MHz) are allocated for potential use in UAS operations under classified as cat. C ("certified"), however their use may still be authorized for operations under the specific category. The use of other licensed bands (e.g., those allocated to mobile networks) may also be authorized under the specific category. Some un-licensed bands (e.g., ISM (Industrial, Scientific, Medical) or SRD (Short Range Devices)) may be acceptable under the specific category, for instance for operations with lower integrity requirements*.

4) Environmental conditions that might affect the C3 links performance.

TECHNICAL ISSUE WITH THE UAS		LEVEL of INTEGRITY		
		Low **(SAIL II & III)**	**Medium** **(SAIL IV)**	**High** **(SAIL V & VI)**
OSO #06 **C3 link characteristics (e.g., performance, spectrum use) are appropriate for the operation**	Criterion	• The applicant determines that performance, RF spectrum usage[1] and environmental conditions for C3 links are adequate to safely conduct the intended operation. • The UAS remote pilot has the means to continuously monitor the C3 performance and ensures the performance continues to meet the operational requirements[2].	Same as Low[3].	Same as Low. In addition, the use of licensed[4] frequency bands for C2 Link is required.
	Comments	*[1] For a low level of integrity, unlicensed frequency bands might be acceptable under certain conditions, e.g.:* • *the applicant demonstrates compliance with other RF spectrum usage requirements (e.g., for EU: Directive 2014/53/EU, for the US: CFR Title 47 Part 15 Federal Communication Commission (FCC) rules), by showing the UAS equipment is compliant with these requirements (e.g., FCC marking), and* • *the use of mechanisms to protect against interference (e.g., FHSS, frequency deconfliction by procedure).*	*[3] Depending on the operation, the use of* licensed *frequency bands might be necessary. In some cases, the use of non-aeronautical bands (e.g., licensed bands for cellular network) may be acceptable.*	*[4] This ensures a minimum level of performance and is not limited to aeronautical licensed frequency bands (e.g., licensed bands for cellular network). Nevertheless, some operations may require the use of bands allocated to the aeronautical mobile service for the use of C2 Link (e.g., 5030 – 5091 MHz).* *In any case, the use of licensed frequency bands needs authorization.*

		[2] The remote pilot has continual and timely access to the relevant C3 information that could affect the safety of flight. For operations requesting only a low level of integrity for this OSO, this could be achieved by monitoring the C2 link signal strength and receiving an alert from the UAS HMI if the signal becomes too low.		

TECHNICAL ISSUE WITH THE UAS		**LEVEL of ASSURANCE**		
		Low (SAIL II & III)	**Medium (SAIL IV)**	**High (SAIL V & VI)**
OSO #06 **C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation**	Criterion	The applicant declares[1] that the required level of integrity has been achieved.	Demonstration of the C3 link performance is in accordance with standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[2].	Same as Medium. In addition, evidence is validated by a competent third party.
	Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority*	*[2] 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.*	*N/A*

OSO #07 – Conformity check of the UAS configuration

1) The intent of this OSO is that the Operator assures the configuration of the UAS intended to be used for the operation conforms to the UAS design data considered under the SORA process.

2) This OSO does not describe a pre or post flight inspection as part of normal operations, these are covered under OSO #8.

<table>
<tr><th colspan="2" rowspan="2">TECHNICAL ISSUE WITH THE UAS</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL I & II)</th><th>Medium
(SAIL III & IV)</th><th>High
(SAIL V & VI)</th></tr>
<tr><td rowspan="2">OSO #07

Conformity check of the UAS configuration</td><td>Criterion</td><td colspan="3">The Operator has UAS conformity check procedures ensuring periodically that:
● the UAS intended to be used for the operation is in a condition for safe operation,
● the UAS configuration conforms to the UAS design data (including any design limitations, e.g., maximum payload weight) considered under the approved concept of operation.</td></tr>
<tr><td>Comments</td><td colspan="3">The distinction between a Low, a Medium and a High level of robustness for this criterion is achieved through the level of assurance (see table below).</td></tr>
</table>

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #07 **Conformity check of the UAS configuration**	Criterion #1 (Procedures)	The UAS conformity check procedures are documented and accounts for the UAS designer's recommendations if available.	Same as Low. In addition, the UAS conformity checks are documented using checklists.	Same as Medium. In addition, the UAS conformity check procedures are validated by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	The remote crew is trained to perform the UAS conformity check. The related training is self-declared (with evidence available).	● A training syllabus including a UAS conformity check procedure is available. ● Evidence of theoretical and practical training is available.	Same as Medium. In addition, a competent third party: ● Validates the training syllabus. ● Verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

OSO #08 – Operational procedures are defined, validated and adhered to

(a) Operational procedures address normal, abnormal and emergency situations potentially resulting from technical issues with the UAS or external systems supporting UAS operation, human errors or critical environmental conditions.

(b) Standard Operating Procedures are a set of instructions covering policies, procedures, and responsibilities set out by the applicant that supports operational personnel in ground and flight operations of the UA safely and consistently during normal situations.

(c) Contingency Procedures are designed to potentially prevent a significant future event (e.g., loss of control of the operation) that has an increased likelihood to occur due to the current abnormal state of the operation. These procedures should return the operation to a normal state and enable the return to using standard operating procedures, or allow the safe cessation of the flight.

(d) Emergency Procedures are intended to mitigate the effect of failures that cause or lead to an emergency condition.

(e) The Emergency Response Plan (ERP) deals with the potential hazardous secondary or escalating effects after a loss of control of the operation (e.g., in the case of ground impact, mid-air collision or flyaway) and is decoupled from the Emergency Procedures, as it does not deal with the control of the UA.

<table>
<tr><th colspan="2" rowspan="2">OPERATIONAL PROCEDURES</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL I)</th><th>Medium
(SAIL II)</th><th>High
(SAIL III to VI)</th></tr>
<tr><td>OSO #08
Operational procedures are defined, validated and adhered to</td><td>Criterion #1
(Procedure definition)</td><td colspan="3">Operational procedures appropriate for the proposed operation are defined and as a minimum cover the following elements:
● Flight planning,
● Pre- and post-flight inspections,
● Procedures to evaluate environmental conditions before and during the mission (i.e., real-time evaluation) including assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple recording system,
● Procedures to cope with unintended adverse environmental conditions (e.g., when ice is encountered during an operation not approved for icing conditions)
● Normal procedures,
● Contingency procedures (to cope with abnormal situations1),
● Emergency procedures (to cope with emergency situations1),</td></tr>
</table>

		● Pre-flight procedures including briefing of any involved persons about the potential risks and actions to take in case of misbehaviour of the UA, and ● Occurrence reporting procedures. If available, operational procedures provided by the UAS designer should be utilized.		
	Comments	*[1] In addition to addressing the deterioration of the UAS itself, operational procedures also need to cover the limitations and deterioration of any external system supporting UAS operation[2/3].* *[2] In the scope of this assessment, external systems supporting UAS operation are defined as systems not already part of the UAS but used to:* ● *launch / take-off the UAS (e.g., catapult launcher), or* ● *undertake pre-flight checks (e.g., online checklist software), or* ● *keep the UA within its operational volume (e.g., GNSS, Satellite Systems, Air Traffic Management, UTM).* *External systems activated/used after the loss of control of the operation are <u>excluded</u> from this definition.* *[3] To properly address the deterioration of external systems supporting UAS operation, it is recommended to:* ● *identify these "external systems",* ● *identify the "external systems" deterioration modes (e.g., complete loss of GNSS, drift of the GNSS, latency issues, …) which would lead to a loss of control of the operation,* ● *describe the means to detect these deterioration modes of the external systems/facilities,* ● *describe procedure(s) used when deterioration is detected (e.g., activation of the Emergency Recovery Capability, switch to a manual control …).*		
	Criterion #2 (Consideration of Potential Human Error)	At a minimum, operational procedures provide: ● a clear distribution and assignment of tasks ● an internal checklist to ensure staff are adequately performing assigned tasks.	Operational procedures take human error into consideration.	Same as Medium. In addition, the Remote Crew[4] receives Crew Resource Management (CRM)[5] training.

	Comments	*N/A*	*N/A*	*[4] In the context of SORA, the term "Remote crew" refers to any person involved in the mission.* *[5] CRM training focuses on the effective use of all remote crew to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*
	Criterion #3 (Emergency Response Plan)	The Emergency Response Plan (ERP): ● is suitable for the situation[6]; ● effectively mitigates all anticipated hazardous secondary effects after the initial crash; ● clearly delineates Remote Crew member(s) duties; ● is practical to use and trained, so that the Remote Crew can execute the procedures effectively under stress. The ERP contains at minimum: ● the list of anticipated emergency situations with secondary effects; ● the procedures for each of the identified anticipated emergency situation (including criteria to identify each of these situations); ● the list of relevant contacts to reach (e.g., Air Traffic Control, police, fire brigade, first responders).		
	Comments	*[6] The ERP should be proportional to the potential secondary effects of a ground impact, i.e., those effects that may occur after the initial ground impact (e.g., fire, release of poisonous gas).*		

<table>
<tr><th colspan="2" rowspan="2">OPERATIONAL PROCEDURES</th><th colspan="3">LEVEL of ASSURANCE</th></tr>
<tr><th>Low
(SAIL I)</th><th>Medium
(SAIL II)</th><th>High
(SAIL III to VI)</th></tr>
<tr><td rowspan="3">OSO #08

Operational procedures are defined, validated and adhered to</td><td>Criteria #1, #2 and #3</td><td>The adequacy of the operational procedures and ERP is declared, except for Emergency Procedures, which are tested.</td><td>● Operational procedures and ERP are developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[1].
● Adequacy of the Contingency and Emergency procedures is proven through:
○ Dedicated flight tests, or
○ Simulation provided the simulation is proven valid for the intended purpose with positive results.</td><td>Same as Medium. In addition:
● Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative.
● The procedures, checklists, flight tests and simulations are validated by a competent third party.
● The representativeness of the tabletop exercise of the ERP is validated by a competent third party.</td></tr>
<tr><td>Comments</td><td>Operational procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority.</td><td colspan="2">[1] 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.
[2] The tabletop exercise may involve the third parties identified in the ERP.</td></tr>
<tr><td>Alternative Criteria #1, #2 and #3 taking credit for functional test-based methods</td><td colspan="3">FUNCTIONAL TEST-BASED METHODS (for SAILs up to IV included)
If the applicant has evidence of FTB flight hours proportionate to the risk/SAIL of the operation meeting one of the set of conditions described either in section E.3(c) or section E.3(d) and executed:
● within the full operational scope/envelope intended by the UAS Operator, and
● following the operational procedures referred to in the operational authorization,</td></tr>
</table>

		then the assurance that the operational procedures are adequate is met at the level corresponding to the SAIL being demonstrated by the functional test-based approach[3].
	Comments	[3] *As an example, if the number of test cycles supporting the FTB flying hours is proportionate to the risk of a SAIL III operation (i.e., 3,000FH), the assurance level for OSO #08 is fulfilled at High Level.*

OSO #09 – Remote crew trained and current

(a) The applicant needs to propose theoretical and practical training:

- appropriate for the operation to be approved, i.e., allowing the remote crew to control the normal, abnormal and emergency situations potentially resulting from technical issues with the UAS or external systems supporting UAS operation, human errors or critical environmental conditions, and
- including proficiency requirements and training recurrences.

(b) The entire remote crew (i.e., any person that performs duties essential to the safety of flight) should undergo a theoretical and practical training specific to their duties (e.g., pre-flight inspection, ground equipment handling, evaluation of the meteorological conditions, etc.).

REMOTE CREW COMPETENCIES		LEVEL of INTEGRITY		
		Low (SAIL I & II) or Service Level 1 as described in Annex H	**Medium (SAIL III & IV) or Service Level 2 as described in Annex H**	**High (SAIL V & VI) or Service Level 3 as described in Annex H**
OSO #09 **Remote crew trained and current**	Criterion	The theoretical and practical training: 1) ensures knowledge of: a) UAS regulation b) UAS airspace operating principles c) Airmanship and aviation safety d) Human performance limitations e) Meteorology and assessment of meteorological conditions f) Navigation/Charts g) UA knowledge h) Operational procedures and ERP i) Use of external services, including service limitations and system recovery if any[1]		

		2) is adequate for the operation, i.e., allows the remote crew to control the normal, abnormal and emergency situations potentially resulting from technical issues with the UAS or external systems supporting UAS operation, human errors or critical environmental conditions.[2/3] 3) specifies or proficiency requirements and training recurrence[1].
	Comments	*[1] If external services are used, the Operator is responsible for using the services in the intended manner (e.g., as defined in a Service Level Agreement) and ensuring that the remote crew is trained to use the service as intended.* *[2] The details of the areas to be covered for the different subjects listed above is provided by JARUS WG1 in "JARUS RECOMMENDATION FOR REMOTE PILOT COMPETENCY (RPC) FOR UAS OPERATIONS IN CATEGORY A (OPEN) AND CATEGORY B (SPECIFIC)" (the aim of this document is to provide recommendations to competent authorities (national authorities or Regional Safety Oversight Organizations) to use their own national legislation, concerning uniform remote pilot competency for operations in Category A (Open) and Category B (Specific).* *[3] The distinction between a Low, a Medium and a High level of robustness for this criterion is achieved through the level of assurance (see table below).*

REMOTE CREW COMPETENCIES		**LEVEL of ASSURANCE**		
		Low (SAIL I & II) or Service Level 1 as described in Annex H	**Medium (SAIL III & IV) or Service Level 2 as described in Annex H**	**High (SAIL V & VI) or Service Level 3 as described in Annex H**
OSO #09 **Remote crew trained and current**	Criterion	Training is self-declared (with evidence available).	• Training syllabus is available. • Evidence of theoretical and practical training is available.	A competent third party: • Validates the training syllabus. • Verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

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

For the purpose of the SORA and this specific OSO, the term “External services supporting UAS operations“ encompasses any interaction with an external Service Provider critical for the safety of the flight, e.g.

- Communication Service Provider (CSP),
- Navigation Service Provider (e.g., Global navigation satellite system),
- UTM Service Providers (including surveillance Supplemental Data Service Provider (SDSP), weather SDSP),
- Externally provided electrical power (e.g., in the case where no emergency backup generator is available and the safety of the flight is dependent on continuous power delivery).

The interface between the UAS Operator and the external services may take the form of a Service Level Agreement (SLA).

DETERIORATION OF EXTERNAL SERVICES SUPPORTING UAS OPERATION		LEVEL of INTEGRITY		
		Low (SAIL I & II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #13 **External services supporting UAS operations are adequate to the operation**	Criterion	The applicant ensures that the level of performance for any externally provided **service critical for the safety of the flight**[1] is adequate for the intended operation. If the externally provided service requires communication between the Operator and the Service Provider, the applicant ensures there is effective communication to support the service provisions. Roles and responsibilities between the applicant and the external Service Provider are defined.		
	Comments	*[1] A service whose loss would directly lead to a loss of control of the operation as identified per OSO#05.*		
	Comments	*N/A*	*N/A*	*Requirements for contracting services with Service Provider may be derived from ICAO Standards and Recommended Practices - SARPS (currently under development).*

DETERIORATION OF EXTERNAL SERVICES SUPPORTING UAS OPERATION		LEVEL of ASSURANCE		
		Low (SAIL I & II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #13 **External services supporting UAS operations are adequate to the operation**	Criterion	The applicant declares[1] that the requested level of performance for any externally provided service necessary for the safety of the flight is achieved.	The applicant has supporting evidence that the required level of performance for any externally provided service required for the safety of the flight can be achieved for the full duration of the mission.	Same as Medium. In addition: ● The evidence of the externally provided service performance is achieved through demonstrations. ● A competent third party validates the claimed level of integrity.

			This may take the form of an SLA or any official commitment that prevails between a Service Provider and the applicant on relevant aspects of the service (including quality, availability, responsibilities). The applicant has means to monitor externally provided services that affect flight-critical systems and take appropriate actions if real-time performance could lead to the loss of control of the operation.	
	Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority.* *Supporting evidence may take the form of a Service-Level Agreement (SLA) or any official commitment that prevails between a Service Provider and the applicant on relevant aspects of the service (including quality, availability, responsibilities).* *As an example, if an applicant uses an external surveillance service they should have evidence available supporting the claim that the service meets performance requirements in Annex D.*	*N/A*	*N/A*

OSO #16 – Multi crew coordination

(a) This OSO applies only when multiple personnel are directly involved in the flight operation.

<table>
<tr><th colspan="2" rowspan="2">HUMAN ERROR</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL I & II)</th><th>Medium
(SAIL III & IV)</th><th>High
(SAIL V & VI)</th></tr>
<tr><td rowspan="4">OSO #16
Multi crew coordination</td><td>Criterion #1
(Procedures)</td><td colspan="3">Procedure(s)[1] to ensure coordination between the crew members and robust and effective communication channels is (are) available and at a minimum cover:
● assignment of tasks to the crew, and
● establishment of step-by-step communications, including a proper phraseology between the remote crew members involved in the aerial part of the operation.</td></tr>
<tr><td>Comments</td><td colspan="3">[1] The distinction between a Low, a Medium, and a High level of robustness for this criterion is achieved through the level of assurance (see table below).</td></tr>
<tr><td>Criterion #2
(Training)</td><td>Remote Crew training covers multi crew coordination</td><td>Same as Low. In addition, the Remote Crew[2] receives Crew Resource Management (CRM)[3] training.</td><td>Same as Medium.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>[2] In line with SORA Annex I, the term “Remote crew” refers to any person that performs duties essential to the safety of flight.
[3] CRM training focuses on the effective use of all remote crew to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.</td><td>N/A</td></tr>
</table>

	Criterion #3 (Communication devices)	N/A	The applicant determines that the performance of communication devices is adequate to safely conduct the intended operation. The remote crew has the means to check the performance of the communication devices at intervals deemed appropriate to ensure the performance continues to meet the operational requirements.	Same as Medium. In addition: communication devices are redundant[4] and comply with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[5].
	Comments	*N/A*	*N/A*	*[4] This implies the provision of an extra device to cope with the failure case of the first device.* *[5] 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.*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #16 **Multi crew coordination**	Criterion #1 (Procedures)	• Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. • The adequacy of the procedures and checklists is declared.	• Procedures are validated against standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[1]. • Adequacy of the procedures is proven through: ○ Dedicated flight tests, or ○ Simulation, provided the simulation is proven valid for the intended purpose with positive results.	Same as Medium. In addition: • Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. • The procedures, flight tests and simulations are validated by a competent third party.
	Comments	*N/A*	*[1] 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.*	*N/A*
	Alternative Criterion #1 taking credit for functional test-based methods	FUNCTIONAL TEST-BASED METHODS (for SAILs up to IV included): If the applicant has evidence of FTB flight hours proportionate to the risk/SAIL of the operation meeting one of the set of conditions described either in section E.3(c) or section E.3(d) and executed: • within the full operational scope/envelope intended by the UAS Operator, and		N/A[3]

		● following the operational procedures referred to in the operational authorization, then the assurance that the operational procedures are adequate is met at the level corresponding to the SAIL being demonstrated by the functional test-based approach[2].		
	Comments	[2] *As an example, if the number of test cycles supporting the FTB flying hours is proportionate to the risk of a SAIL III operation (i.e., 3,000FH), the assurance level for OSO#16 Criterion #1 is fulfilled at Medium Level.*		[3] *Functional test-based method are not considered feasible for operations with a SAIL V or VI.*
	Criterion #2 (Training)	Training is self-declared (with evidence available)	● Training syllabus is available. ● Evidence of theoretical and practical training is available.	A competent third party: ● Validates the training syllabus. ● Verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #3 (Communication devices)	N/A	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[4], inspection, design review or through operational experience.	A competent third party validates the claimed level of integrity.
	Comments	*N/A*	[4] *When simulation is* used*, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*

OSO #17 – Remote crew is fit to operate

(a) For the purpose of this assessment, the expression “fit to operate” should be interpreted as physically and mentally fit to perform duties and discharge responsibilities safely.

(b) Fatigue and stress are contributory factors to human error. Therefore, to ensure vigilance is maintained at a satisfactory level of safety, consideration may be given to the following:

- Remote Crew workload and duty times;
- Regular breaks;
- Rest periods;
- Handover/Take Over procedures;
- Personal Protective Equipment (PPE);
- Workplace environment, including ergonomics of the workstation.

HUMAN ERROR		LEVEL of INTEGRITY		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #17 **Remote crew is fit to operate**	Criterion	The applicant has a policy defining the criteria[1] and the means for the remote crew to declare themselves fit before starting their duty and report themselves unfit, if required, during their shift.	Same as Low. In addition: ● Duty, flight duty and resting times for the remote crew are defined by the applicant and adequate for the operation. ● The Operator defines requirements appropriate for the remote crew to operate the UAS.	Same as Medium. In addition: ● The remote crew is medically fit, ● A Fatigue Risk Management System (FRMS) is in place to manage any escalation in duty/flight duty times.
	Comments	*[1] Criteria should take into account local legislation and may cover drugs (including prescriptions) and alcohol consumption.*	*N/A*	*N/A*

<table>
<tr><th colspan="2" rowspan="2">HUMAN ERROR</th><th colspan="3">LEVEL of ASSURANCE</th></tr>
<tr><th>Low
(SAIL I & II)</th><th>Medium
(SAIL III & IV)</th><th>High
(SAIL V & VI)</th></tr>
<tr><td rowspan="2">OSO #17

Remote crew is fit to operate</td><td>Criterion</td><td>The policy defining the criteria and the means for the remote crew to declare themselves fit before starting their duty and report themselves unfit, if required during their shift is documented.</td><td>Same as Low. In addition:
● Remote crew duty, flight duty and the resting times policy is documented.
● Remote crew duty cycles are logged and cover at a minimum:
○ when the remote crew member's duty day commences,
○ when the remote crew members are free from duties,
○ resting times within the duty cycle.</td><td>Same as Medium. In addition:
● Medical standards considered adequate by the competent authority and/or means of compliance acceptable to that authority[1] are established and a competent third party verifies the remote crew is medically fit.
● A competent third party validates the duty/flight duty times.
● The FRMS is validated by a competent third party and internally monitored by the Operator.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>N/A</td><td>[1] 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.</td></tr>
</table>

OSO #18 – Automatic protection of the flight envelope from human errors

(a) Unmanned Aircraft (UA) are designed with a flight envelope that describes its safe performance limits with regard to minimum and maximum operating speeds, and operating structural strength.

(b) Automatic protection of the flight envelope is intended to prevent the remote pilot from operating the UA outside its flight envelope. If the applicant demonstrates that the remote pilot is not in the loop, this OSO is not applicable.

(c) UAS implementing such automatic protection function will ensure the UA is operated within an acceptable flight envelope margin even in the case of incorrect remote-pilot control input (human error).

(d) UAS without automatic protection function are susceptible to incorrect remote-pilot control inputs (human errors) which can result in loss of the UA if the performance limits of the aircraft are exceeded.

(e) Failures or development errors of the flight envelope protection are addressed in OSO #5.

<table>
<tr><th colspan="2" rowspan="2">HUMAN ERROR</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL III)</th><th>Medium
(SAIL IV)</th><th>High
(SAIL V & VI)</th></tr>
<tr><td rowspan="2">OSO #18

Automatic protection of the flight envelope from human errors</td><td>Criterion</td><td>The UAS incorporates automatic protection of the flight envelope to prevent the remote pilot from making any <u>single</u> input under <u>normal operating conditions</u> that would cause the UA to exceed its flight envelope or prevent it from recovering in a timely fashion.</td><td colspan="2">The UAS incorporates automatic protection of the flight envelope to ensure the UA remains within the flight envelope or ensures a timely recovery to the designed operational flight envelope <u>following remote pilot error(s)</u>.[1/2]</td></tr>
<tr><td>Comments</td><td>N/A</td><td colspan="2">[1] The distinction between a Medium and a High level of robustness for this criterion is achieved through the level of assurance (see table below).

[2] Compared to the Low level of robustness, Medium and a High levels need to address any operating conditions (normal, abnormal and emergency) and the potential for multiple errors.</td></tr>
</table>

HUMAN ERROR		LEVEL of ASSURANCE		
		Low (SAIL III)	**Medium (SAIL IV)**	**High (SAIL V & VI)**
OSO #18 **Automatic protection of the flight envelope from human errors**	Criterion	The automatic protection of the flight envelope has been developed in-house or out of the box (e.g., using Commercial Off The Shelf elements), without following specific standards.	The automatic protection of the flight envelope has been developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[1].	Same as Medium. In addition, evidence is validated by a competent third party.
	Comments	*N/A*	*[1] 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.*	*N/A*

OSO #19 – Safe recovery from Human Error

(a) This OSO addresses the risk of human errors that may affect the safety of the operation if they are not prevented or are not detected and recovered in a timely fashion.

  i) Any person involved in the operation is at risk of human errors

  ii) An example could be the flight crew incorrectly loading the payload onto the UAS, causing the payload to fall off the UA during the operation.

  iii) Another example could be the flight crew incorrectly extending or deploying an antenna mast, reducing the C2 link coverage.

  Note: the flight envelope protection is excluded from this OSO since it is specifically covered by OSO #18.

(b) This OSO covers UAS design, i.e., systems detecting and/or recovering from human errors (e.g., functional tests, safety pins, use of acknowledgment features, fuel or energy consumption monitoring functions).

(c) Operational procedures and training are covered in OSO#08 and OSO#09 respectively.

HUMAN ERROR		**LEVEL of INTEGRITY**		
		Low (SAIL III)	**Medium (SAIL IV & V)**	**High (SAIL VI)**
OSO #19 Safe recovery from Human Error	Criterion	Systems detecting and/or recovering from human errors are developed to industry best practices.	Systems detecting and/or recovering from human errors are developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[1].	Same as Medium.
	Comments	*N/A*	*[1] 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.*	*N/A*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low (SAIL III)	**Medium (SAIL IV & V)**	**High (SAIL VI)**
OSO #19 **Safe recovery from Human Error**	Criterion	The applicant declares[1] that the required level of integrity has been achieved.	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience.	A competent third party validates the claimed level of integrity.
	Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority.*	*[2] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*

OSO #20 – A Human Factors evaluation has been performed and the Human-Machine Interface (HMI) found appropriate for the mission

<table>
<tr><th colspan="2" rowspan="2">HUMAN ERROR</th><th colspan="3">LEVEL of INTEGRITY</th></tr>
<tr><th>Low
(SAIL II & III)</th><th>Medium
(SAIL IV & V)</th><th>High
(SAIL VI)</th></tr>
<tr><td rowspan="2">OSO #20
A Human Factors evaluation has been performed and the HMI found appropriate for the mission</td><td>Criterion</td><td colspan="2">The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation.</td><td>Same as Medium. In addition, the Human Factors evaluation is expected to cover:
● an appraisal to check that the remote crew workload remains acceptable in both normal and emergency situations;
● an appraisal of the efficiency of the emergency procedures (efficacy of the actions, expected potential latencies);
● analyses to check if prioritization of alarms and emergency procedures should be put in place to organize emergency procedures in such a way that they remain adapted to the criticality of the situation.</td></tr>
<tr><td>Comments</td><td colspan="3">If an electronic means is used to support the remote crew members in their role to maintain awareness of the position of the unmanned aircraft, its HMI:
● is sufficient to allow the remote crew members to determine the position of the UA during operation;
● does not degrade the remote crew members’ ability to:
○ scan the airspace visually where the unmanned aircraft is operating for any potential collision hazard; and
○ maintain effective communication with the remote pilot at all times.</td></tr>
</table>

HUMAN ERROR		LEVEL of ASSURANCE		
		Low (SAIL II & III)	**Medium (SAIL IV & V)**	**High (SAIL VI)**
OSO #20 **A Human Factors evaluation has been performed and the HMI found appropriate for the mission**	Criterion	The applicant conducts a human factors evaluation of the UAS to determine if the HMI is appropriate for the mission. The HMI evaluation is based on inspection or analyses. The adequacy of the result of the HMI evaluation is declared.	Same as Low but the HMI evaluation is based on demonstrations or simulations.[1]	Same as Medium. In addition, a competent third party witnesses the HMI evaluation.
	Comments	*N/A*	*[1] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*
	Alternative Criterion taking credit for functional test-based methods	If the applicant has evidence of FTB flight hours proportionate to the risk/SAIL of the operation meeting one of the set of conditions described either in section E.3(c) or section E.3(d) and executed: ● within the full operational scope/envelope intended by the UAS Operator, and ● following the operational procedures and the remote crew training referred to in the operational authorization, then the assurance that the operational procedures are adequate is met at the level corresponding to the SAIL being demonstrated by the functional test-based approach[2].		N/A[3]
	Comments	*[2] As an example, if the number of test cycles supporting the FTB flying hours is proportionate to the risk of a SAIL III operation (i.e., 3,000FH), the assurance level for OSO#20 is fulfilled at Low Level.*		*[3] Functional test-based method are not considered feasible for operations with a SAIL VI*

OSO #23 – Environmental conditions for safe operations defined, measurable and adhered to

(a) Environmental conditions include meteorological conditions such as wind, rain, and icing, as well as external factors that may interfere with the performance of systems such as High-Intensity Radiated Field (HIRF).

ADVERSE OPERATING CONDITIONS		LEVEL of INTEGRITY		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #23 **Environmental conditions for safe operations defined, measurable and adhered to**	Criterion	Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document.[1]		
	Comments	*[1] The distinction between a Low, a Medium and a High level of robustness for this criterion is achieved through the level of assurance (see table below).*		

ADVERSE OPERATING CONDITIONS		LEVEL of ASSURANCE		
		Low (SAIL I & II)	**Medium (SAIL III & IV)**	**High (SAIL V & VI)**
OSO #23 **Environmental conditions for safe operations defined, measurable and adhered to**	Criterion	The applicant declares[1] that the required level of integrity has been achieved.	The applicant has supporting evidence that the required level of integrity is achieved.	A competent third party validates the claimed level of integrity.
	Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority.*	*N/A*	*N/A*

OSO #24 – UAS designed and qualified for adverse environmental conditions (e.g., adequate sensors, DO-160 qualification)

(a) To assess the integrity of this OSO, the applicant determines:

- If credit can be taken for the equipment environmental qualification tests / declarations, e.g., by answering the following questions:

  i. *Is there a Declaration of Design and Performance (DDP) available to the applicant stating the environmental qualification levels to which the equipment was tested?*

  ii. *Did the environmental qualification tests follow a standard considered adequate by the competent authority (e.g., RTCA DO-160 "Environmental Conditions and Test Procedures for Airborne Equipment")?*

  iii. *Are the environmental qualification tests appropriate and sufficient to cover all environmental conditions intended by the UAS Operator?*

  iv. *If the tests were not performed following a recognized standard, were the tests performed by an organization/entity being qualified or having experience in performing DO-160 like tests?*

- Can the suitability of the equipment for the intended/expected UAS environmental conditions be determined from either in-service experience or relevant test results?
- Any limitations which would affect the suitability of the equipment for the intended/expected UAS environment conditions.

(b) The lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

ADVERSE OPERATING CONDITIONS		LEVEL of INTEGRITY		
		N/A	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #24 **UAS designed and qualified for adverse environmental conditions**	Criterion	N/A	The UAS is designed to perform as intended in the environmental conditions defined and reflected in the flight manual or equivalent document.	The UAS is designed using environmental standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority[1].
	Comments	*N/A*	*As an example, if a UAS is proposed to be operated in raining conditions, it is not necessarily proposed to comply with DO-160G waterproof conditions; rain conditions can be limited as* long *as representative of the environmental conditions.*	*[1] National Aviation Authorities (NAAs) may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.*

<table>
<tr><th colspan="2" rowspan="2">ADVERSE OPERATING CONDITIONS</th><th colspan="3">LEVEL of ASSURANCE</th></tr>
<tr><th>N/A</th><th>Medium
(SAIL III)</th><th>High
(SAIL IV to VI)</th></tr>
<tr><td rowspan="4">OSO #24

UAS designed and qualified for adverse environmental conditions</td><td>Criterion</td><td>N/A</td><td>The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[1], inspection, design review or through operational experience.</td><td>A competent third party validates the claimed level of integrity.</td></tr>
<tr><td>Comments</td><td>N/A</td><td>[1] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.</td><td>N/A</td></tr>
<tr><td>Alternative Criterion taking credit for functional test-based methods</td><td>N/A</td><td colspan="2">FUNCTIONAL TEST-BASED METHODS (for SAILs up to SAIL IV included):

If the applicant has evidence of FTB flight hours proportionate to the risk/SAIL of the operation meeting one of the set of conditions described either in section E.3(c) or section E.3(d) and executed:

● within the full operational scope/envelope intended by the UAS Operator, and

● following the maintenance, operational procedures and the remote crew training referred to in the operational authorization,

then the assurance that the operational procedures are adequate is met at the level corresponding to the SAIL being demonstrated by the functional test-based approach[2].</td></tr>
<tr><td>Comments</td><td>N/A</td><td colspan="2">[2] As an example, if the number of test cycles supporting the FTB flying hours is proportionate to the risk of a SAIL III operation (i.e. 3,000FH), the assurance level for OSO#24 is fulfilled at Medium Level.</td></tr>
</table>

E.3 Functional Test-Based (FTB) Approach

a. The objective of this section is to give some insight into the Functional Test-Based (FTB) approach referenced throughout Annex E. This is articulated around three different but complementary perspectives:

   i. FTB as a Means of Compliance (MoC) to support **UAS designers** in demonstrating UAS operational reliability for the purposes of obtaining an FTB design appraisal;

   ii. FTB design appraisal gained by UAS designers taken credit for by **UAS operators** when showing compliance with some of Annex E OSOs;

   iii. FTB as a means for **UAS operators** to take credit for safe and successful operations over time to expand their operational approval (based on the concept of "reliability growth model").

   These three approaches are detailed in the following sections b), c) and d).

b. FTB as a Means of Compliance (MoC) to support **UAS designers** in demonstrating UAS operational reliability:

   i. Several major competent authorities around the world are adopting functional test-based approaches as a MoC to support UAS designers in demonstrating the UAS operational reliability, i.e., demonstrating an acceptable operational hazard rate across all likely operational states and environments, as well as help expose unacceptable early mortality[1] and wear out failures across an acceptable sample size of unmanned aircraft[2].

   ii. Depending on the principles agreed with the competent authority, a test-based approach may cover both functional tests and induced failure tests, which are defined as follows:

      - 'functional tests' are operational test cycles fully representative of end-state operations with test points to verify safe operation at the operational limits and corners of the UA envelope;

      - 'induced failure tests' are specific tests where operationally-representative cycles alone may not provide sufficient detail, e.g. to cover likely failures. These tests typically address demand-based systems (i.e., systems that are not continuously active and could be triggered only under certain [failure] conditions) which need to be assessed separately to demonstrate adequate reliability.

   iii. While it is not the objective of this section to prescribe Means of Compliance for a Functional test-based approach, competent authorities may want to consider the principles laid down in ASTM F3478-20: "Standard Practice for Development of a Durability and Reliability Flight Demonstration Program for Low Risk Unmanned Aircraft Systems (UAS) under FAA Oversight.", some of its concepts being highlighted below:

      - An adequate functional test-based campaign will include mostly operational flight tests; it may include as well specific (ground) testing to verify underlying system parameters statistically (e.g., component Mean Time Between Failures (MTBF), UA MTBF, operational hazard rates, parachute reliability). Both the UAS designer and the competent authority need to understand the assumptions made when attributing a distribution type to a system parameter (e.g., exponential, normal, Weibull, gamma distributions).

      - Any infringement or loss of control occurring during the test campaign will require a root cause analysis. If following the investigation, design modifications are necessary, an analysis will need to be performed to assess whether the FTB flying hours performed before the application of the change can still be considered valid. In some cases, the tests may have to restart from the beginning.

      - UAS designers and competent authorities should also be cognisant of systems, such as software- or

[1] also referred to as Infant Mortality as per bathtub curve terminology (https://www.itl.nist.gov/div898/handbook/apr/section1/apr124.htm)

[2] The sample size will need to be defined and agreed with the competent authority to ensure that an individual system under test operates throughout a not insignificant portion of its intended operational life, and to ensure that there is appropriate consistency of operational reliability & performance across multiple systems during testing.

airborne electronic hardware-based systems, that do not allow accurate analysis under operational time or demand-based testing. These systems should use system-specific analyses (e.g., multiple condition/decision coverage, model checking, development assurance, design and analysis) appropriate to the SAIL level.

iv. The competent authority may grant a specific flight test authorization to enable such functional and induced failure tests needed to complete an FTB method.

c. FTB design appraisal gained by UAS designers taken credit for by **UAS operators** when showing compliance with some of Annex E OSOs:

i. An FTB design appraisal gained by a UAS designer presents several benefits both for the UAS Operator going through the Operational Authorization (OA) process and the Competent Authority issuing such OA, in particular when the UAS Operator does not have a full relationship with the designer or does not have all the design details.

ii. In order for a UAS Operator to take credit for a FTB design appraisal gained by a UAS designer, the following conditions need to be met at a minimum:

- The functional tests supporting the FTB design appraisal gained by a UAS designer have been executed within the full operational scope/envelope intended by the UAS Operator; this means that the test cycles are fully representative of the operators' intended operations with test points to verify safe operation at the operational limits and corners of the vehicle envelope.
- The functional tests supporting the FTB design appraisal gained by a UAS designer have been executed following the operational procedures and the remote crew training referred to in the operational authorization (and meeting the integrity assurance of the associated OSOs).
- The UAS operator maintenance instructions are established based on the UAS designer's instructions and requirements which were used for maintenance, repair, or replacement of UAS sub-systems during the functional tests supporting the FTB design appraisal gained by the UAS designer.
- Any UAS configuration differences compared to the initial configuration used by the UAS designer to gain the FTB design appraisal are confirmed by the UAS designer not to impair the validity of the design appraisal.
- The minimum number of test cycles are proportionate to the risk of the operation, with at least:
    - 30 hours for SAIL I;
    - 300 hours for SAIL II;
    - 3,000 hours for SAIL III; and
    - 30,000 hours for SAIL IV

  in order to achieve a 95% confidence (assuming a binomial/Poisson distribution for the operational level hazard rate and no failures during the test)[3].

  Note that FTB methods are not considered feasible for UAS operations with a SAIL above or equal to V.
- The functional tests supporting the FTB design appraisal gained by a UAS designer have been executed by the UAS designer according to principles/standards considered adequate by the competent authority in charge of granting the Operational Authorization, including at a minimum the following principles:

[3] See the Rule of Three: https://en.wikipedia.org/wiki/Rule_of_three_(statistics)

- The functional tests supporting the FTB design appraisal gained by a UAS designer have been executed using an acceptable sample size of unmanned aircraft.

- Safe life limits for UAS subsystems sensitive to wear-out conditions based on the maximum cycles and hours demonstrated by one or more fleet leader UAS (i.e. the UAS with the longest time and/or cycles compared to other UAS used during the FTB testing) have been derived by the UAS designer and captured in the FTB design appraisal limitations.

iii. Additionally, induced failure tests may help demonstrate compliance with the following OSOs and the containment requirements of section E.4:

- OSO#05 and section E.4 containment requirements: safety and reliability / safe design (e.g., induced failure tests with no loss of control or containment as path-fail criteria);
- OSO#06: C3 link performance appropriate for the operation (e.g., if the distance from a C2 radio transmitter/receiver is a critical factor, then the demonstration of the maximum allowable range from the transmitter/receiver in the most likely worst-case conditions is needed);
- OSO#18: Automatic protection of the flight envelope from human errors;

<u>However, this kind of test is not addressed in this version of Annex E (v2.5) since competent authorities are still in the process of defining the modalities of test-based approaches</u>. In the meantime, credit for induced failure testing may be proposed on a case-by-case basis by a UAS Operator depending on the scope of the FTB design appraisal gained by the UAS designer.

d. FTB as a means **<u>for UAS operators</u>** to take credit for safe and successful operations over time to expand their operational approvals (based on the concept of “reliability growth model”):

i. An FTB approach should also allow UAS Operators to take credit for safe and successful operations over time to expand their operational approvals based on the concept of “reliability growth”, while still respecting the conditions of section E.3(c).

ii. UAS Operators should be able to operate with a low SAIL approval and then, through operational experience, gather sufficient operational data to justify an increase in the SAIL, based upon the increase in operational reliability demonstrated by the operators. This approach would only be valid <u>under representative operating conditions, not requesting additional strategic or tactical mitigations</u>.

Notes:

- The competent authority may accept accumulation of FTB hours between operators if the UAS configuration, operational procedures, training, etc. are demonstrated to be equivalent.
- This option does not cover expanded operating conditions which would require additional testing and/or analysis to be performed by the UAS designer. As an example, a UAS Operator may start with a SAIL II operational approval to fly over population density up to 500 ppl/km2 and, if they demonstrate 3,000 hours with no loss of control, they could be allowed to fly a SAIL III operation under the exact same operating conditions, except for an increase of the maximum population density allowed (5,000 ppl/km2).

iii. To be relevant, the UAS Operator would need to show that:

- the next population band does not introduce new or unique hazards, or if so, these new or unique hazards are shown to be properly mitigated through test or analysis;
- the reliability demonstrated through operational testing demonstrates the required operational reliability at the higher SAIL level desired;
- any UAS configuration differences compared to the initial configuration do not impair the validity of the argument.

E.4 Containment requirements

a. In SORA Main Body, Step #8: Determination of containment requirements addresses the risk posed by an operational loss of control that could infringe on areas adjacent to the operational volume and buffers. The ground risk (in the adjacent area) and air risk in the adjacent airspace dictate the level of safety requirements to be met by containment design features and operational procedures.

b. The following section provides the generic containment requirements for the following 3 levels of containment: Low, Medium and High.

Containment	**LEVEL of INTEGRITY**		
	Low	**Medium**	**High**[2]
Criterion #1 (Operational Volume Containment)	(Qualitative) No **probable**[1] single 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" shall be less than 10-3/Flight Hour (FH).		(Qualitative) No **remote**[3] single 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" shall be less than 10-4/FH.
Comments	*[1] Failures anticipated to occur one or more times during the entire operational life of an item.*		*[2] This may be achieved by a tether that prevents the drone from exiting the operational volume.* *[3] Failures unlikely to occur with each UA during its operational life but that may occur several times when considering the total operational life of a number of UA of this type.*

<table>
<tr><td></td><td colspan="2"></td><td>[4] This means a reduction by a factor of 10 of the likelihood of exiting the operational volume compared to the low & medium integrity containment.</td></tr>
<tr><td>Criterion #2
(End of Flight upon exit of the operational volume)</td><td colspan="3">When the UA leaves the operational volume, an immediate end of the flight must be initiated through a combination of procedures/processes and/or available technical means.</td></tr>
<tr><td>Comments</td><td colspan="3">N/A</td></tr>
<tr><td>Criterion #3
(Definition of the final ground risk buffer)</td><td>The Ground Risk Buffer must at least adhere to the 1:1 principle[5].
The 1:1 rule may not be suitable for some UA configurations (e.g., fixed-wing or parachute-equipped UA). In those cases, the competent authority may require to define the ground risk buffer based on a ballistic methodology approach, a glide trajectory, representative flight tests, and/or a combination thereof.
A smaller ground risk buffer value may be proven by the applicant for a rotary wing UA using a ballistic methodology approach acceptable to the competent authority.</td><td colspan="2">Ground risk buffer must consider the following points below:
● <u>Probable</u>[6] single failures (including the projection of high energy parts such as rotors and propellers) which would lead to an operation outside of the operational volume,
● Meteorological conditions (e.g., maximum sustained wind),
● UAS latencies (e.g., latencies that affect the timely manoeuvrability of the UA),
● UA behaviour when activating a technical containment measure, UA performance.</td></tr>
</table>

Comments	[5] *The 1:1 principle refers to applying a ground risk buffer that is as wide as the maximum height of* the *operational volume*	[6] *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 operational life of a UAS"..*
Criterion #4 (Ground risk buffer containment)	N/A	**No single failure**[7] of the UAS or any external system supporting the operation shall lead to operation **outside of the ground risk buffer**. 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.
Comments	*N/A*	[7]*Example* methods *of achieving this may include:* ● *an independent Flight Termination Systems (FTS), that will initiate the end of the flight, when exiting the operational volume; or* ● *a secondary independent emergency flight control system, that ends the flight in a controlled manner; or* ● *a tether that prevents the drone from exiting the ground risk buffer;* ● *a fail safe health monitoring system that triggers in the event of a critical feature failure (such as navigation).*

<table>
<tr><th rowspan="2">Containment</th><th colspan="3">LEVEL of ASSURANCE</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td>For all criteria</td><td>The applicant declares[1] that the required level of integrity has been achieved.
The declaration of the applicant should in particular rely on:
● For <u>criterion #1</u>, a design and installation appraisal[2] including at minimum:
○ design and installation features (e.g., independence, separation or redundancy claims);
○ any relevant particular risk (e.g., hail, ice, snow, electro-magnetic interference…) associated with the operation and how they are being addressed.
● For <u>criterion #2</u>, the adequacy of Emergency Procedures to terminate flight are tested.</td><td>The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience.
Among the supporting evidences:
● For <u>criterion #1 and criterion #4</u>: Same as criterion #1 low.
● For <u>criterion #2</u>: Adequacy of the Emergency Procedures to terminate flight are proven through:
○ dedicated flight tests, or
○ simulation provided the simulation is proven valid for the intended purpose with positive results.</td><td>Same as Medium.
In addition, a competent third party validates the claimed level of integrity.</td></tr>
<tr><td>Comments</td><td>[1] Supporting evidence for this declaration may still be requested by the competent authority.</td><td>[2] When simulation is used, the suitability of the targeted environment used in the simulation needs to be justified.</td><td>N/A</td></tr>
</table>

	[2] A simple written justification from the operator including functional diagrams and a description of how the system works explaining why the integrity claim (i.e. no (probable/remote) single failure criterion) is met is an acceptable means of compliance.		

c. The following section is an alternative to section b which can only be used in the specific use of a tether:

Containment specific criteria in case of tethered operations	**LEVEL of INTEGRITY**
	Low, Medium and High[1]
Criterion #1 (Technical design)	1) The length of the line is adequate to contain the UA in the operational volume. 2) Strength of the line is compatible with the ultimate loads[2] expected during the operation. 3) Strength of attachment points is compatible with the ultimate loads[2] expected during the operation. 4) The tether cannot be cut by rotating propellers.
Comments	*N/A*
Criterion #2 (Procedures)	The applicant has procedures to install and periodically inspect the condition of the tether.
Comments	*[1] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 5 below).* *[2] Ultimate loads are identified as the maximum loads to be expected in service, including all possible nominal and failure scenarios multiplied by a 1.5 factor of safety.*

Containment specific criteria in case of tethered operations	LEVEL of ASSURANCE		
	Low	**Medium**	**High**
Criterion #1 (Technical design)	The applicant declares[1] that the required level of integrity has been achieved.	The applicant has supporting evidence (including the tether material specifications) to claim the required level of integrity is achieved. ● This is typically achieved through testing or operational experience. ● Tests can be based on simulations, however the validity of the target environment used in the simulation needs to be justified.	The claimed level of integrity is validated by a competent third party
Comments	*[1] Supporting evidence for this declaration may still be requested by the competent authority.*	*N/A*	*N/A*
Criterion #2 (Procedures)	● Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. ● The adequacy of the procedures is declared.	● Procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. ● The adequacy of the procedures is proved through: ○ Dedicated flight tests, or ○ Simulation provided the simulation is proven valid for the intended purpose with positive results. ○	Same as Medium. In addition: ● Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. ● The procedures, flight tests and simulations are validated by a competent third party.

Comments	*N/A*	*[1] National Aviation Authorities (NAAs) may define the standards and/or the means of compliance they consider adequate. The SORA Annex B will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.*	*N/A*