JARUS Joint Authorities for Rulemaking on Unmanned Systems

JARUS WG-Airworthiness Taskforce 2

FAA D & R and EASA SC Light-UAS including Functional Test Based MoC Requirements

Factual Comparison

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		Update following completion of EASA Light UAS SC vs. FAA D&R Comparison table 9no FTB) of Annex 5	p. 26 and Annex 5
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Special thanks to the TF-2 coming from all over the world.

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EXECUTIVE SUMMARY

Both FAA and EASA have defined Type Certification / Operational Authorization requirements for the operation of Light Unmanned Aircraft.

While both authorities have endorsed the proportionate risk-based approach to define those requirements, there are some differences in the process that the JARUS WG-AW Taskforce 2 has been tasked to analyze.

The purpose of this white paper is to present a factual comparison between FAA and EASA requirements. This white paper does not harmonize FAA and EASA positions. It just provides a perspective by comparing side by side.

Currently, the FAA is in rulemaking activity; thus, the information presented in this paper is subject to change depending on a new policy revised after rulemaking activities are completed.

Similarly, SORA JARUS 2.5, used in this white paper, is under comment disposition; thus, this paper may not represent the latest requirements and processes for determining the operational risk assessment.

The paper shows differences in the EASA and FAA's processes up to these moments. These differences manifest in applicability, airworthiness requirements, functional test base approach hours, and possibly, in estimating input parameters to calculate the Target Level of Safety.

As a result, JARUS AW-TF2 met with the certification management team (CMT) and has formed a team of experts to harmonize EASA, FAA, TCCA, and ANAC requirements.

This white paper is divided into the following sections:

1) Defines the methodology used to compare EASA and the FAA rule sets
2) Provide definitions from DNR 21.17(b) issued airworthiness requirements for AMAZON, Matternet, Scaneagle, and EASA SC-Light UAS. In addition, this section shows that the EASA uses normal, operational, and limited flight envelopes, which are absent in the FAA airworthiness requirements.
3) Compares EASA and FAA rules. First, it uses the FAA applicability on airworthiness requirements to establish the top-level conceptual CONOPS; then, it uses SORA to obtain SAILs to compare SAIL obtained against EASA comparable operations. Furthermore, it compares the hours to achieve authority approvals.
4) Compares rule by rule and only highlights the differences
5) The annexes complement the sections discussed above

Disclaimer 1: This document shall not be viewed as an attempt to harmonize FAA and EASA approaches but rather to help potential applicants in Europe, and the USA understand their differences and consequences.

Disclaimer 2: This document is based upon the current status of EASA and FAA requirements as formally known at the issuance time. Further ongoing updates of these requirements may or may not validate the conclusions currently reached and may lead to its update in the future.

REFERENCES

FAA

(1) FAA CPP-D&R-1.1, Certification Basis for Unmanned Aircraft Utilizing Durability and Reliability

(2) FAA CPP-D&R-2.1, Means of Compliance for Unmanned Aircraft Utilizing Durability and Reliability

(3) FAA Memorandum AIR600-21-600-DM01, Revision 1 Deviation for the Certification of Low-Risk Unmanned Aircraft

(4) FAA Memorandum AIR600-21-600-DM02, Deviation to Order 8110.118, Commercial Parts, to Facilitate Use of Commercial Parts for Low-Risk Unmanned Aircraft Systems;

(5) FAA Memorandum AIR600-21-AIR-600-PM-01, FAA Approval of Unmanned Aircraft Systems (UAS) Special Class U.A. Projects and their Associated Elements

(6) Amazon Prime Air – FAA-2019-0573 Petition Exemption Under 49 U.S.C. § 44807 and 14 C.F.R. Parts 61, 91, and 135

(7) UPS Part 135 exemption FAA-2019-0652

(8) https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/uasrtfarc-102015.pdf

EASA

(9) EASA SC Light-UAS Medium Risk Issue 1 (17.12.2020) and High Risk (22.12.2022), Special Condition for Light Unmanned Aircraft Systems -

(10) FTB MOC SC Light UAS Issue 1 (26.05.2022), Means of Compliance to Special Condition Light UAS for UAS operated in SAIL III and below

(11) EASA Easy Access Rules for Unmanned Aircraft Systems as of September 2022, AMC1 Article 11 Rules for conducting an operational risk assessment. Specific Operational Risk Assessment (Source JARUS SORA V2.0)

(12) EASA Design Verification Compliance matrix (correlation between OSOs and S.C. requirements)

(13) Guidelines on Design verification of UAS operated in the 'specific' category and classified in SAIL III and IV

(14) Draft JARUS SORA 2.5 dated 08.11.2022, released for public comments until March 6, 2023

(15) 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

1. WORK METHODOLOGY

The work presented in this document has been performed using the materials in the currently available referenced documents, in particular:

- FAA CPP-D&R-1.1, Certification Basis for Unmanned Aircraft Utilizing Durability and Reliability, which provides a set of Special Airworthiness Criteria used for recent Light U.A. applications based upon Durability & Reliability Demonstration Concept
- EASA SC Light-UAS Medium Risk Issue 1, Special Condition for Light Unmanned Aircraft Systems - Medium Risk (i.e., SAIL III as defined in SORA methodology)
- FTB (Functional Test Based) MOC SC Light UAS Issue 1, Means of Compliance to Special Condition Light UAS for UAS operated in SAIL III and below (that allows showing compliance with some of the EASA Light UAS SC requirements instead of traditional means of compliance ref.
- Draft JARUS SORA 2.5 released for public comments on TBD, which has also introduced the FTB approach to show compliance with some of the Design Related SORA Operational Safety Objectives for SAIIL II, SAIL III, and SAIL IV ref. (12)

The comparison will cover several different aspects

- It shall be performed on similar CONOPS (Ground and Air Risks, U.A. characteristics) to be identified and derived from the applicability of both FAA and EASA requirements and based upon identified FAA and EASA references
- It will address the EASA Function Test Based MoC and FAA D&R approaches, namely in terms of required flight test hours
- It will review the EASA Light SC UAS requirements (that cannot be complied with using FTBas MoC but rather traditional means of compliance) and "parallel" FAA D&R requirements, especially those not related to Durability and Reliability testing
- In addition, the impact of the emerging SORA 2.5 FTB MoC (for OSOs) on this comparison will also be analyzed.

2. DEFINITIONS

2.1. FAA

Special Classes of Aircraft. The FAA determined that some U.A. may be type certificated as a special class of Aircraft under 14 CFR 21.17(b) and published as a notice of this policy in the Federal Register (85 FR 58251, September 18, 2020. AIR-600 is responsible for defining airworthiness criteria for low-risk U.A. and providing these criteria to the ACO Branch for the project.

Unmanned Aircraft (U.A.): an aircraft operated without the possibility of direct human intervention from within or on the Aircraft.

Unmanned Aircraft System (UAS): an unmanned aircraft *and associated elements* (including communication links and the components that control the unmanned Aircraft) that are required for the operator to operate safely and efficiently in the national airspace system

Loss of Control: Loss of control means an unintended departure of an aircraft from a controlled flight. It includes control reversal or an undue loss of longitudinal, lateral, and directional stability and control. It also includes an upset or entry into an unscheduled or uncommanded attitude with a high potential for uncontrolled impact with terrain. A loss of control means a spin, loss of control authority, loss of aerodynamic stability, divergent flight characteristics, or similar occurrences, which could generally lead to a crash.

Loss of Flight: Loss of flight means a U.A.'s inability to complete its flight as planned, up to and through its originally planned landing. It includes scenarios where the U.A. experiences controlled flight into terrain, obstacles, any other collision, or a loss of Altitude that is severe or non-reversible. Loss of flight also includes deploying a parachute or ballistic recovery system that leads to an unplanned landing outside the operator's designated recovery zone.

2.2. EASA / EU

Unmanned Aircraft means any aircraft operating or designed to operate autonomously or piloted remotely without a pilot on board.

An unmanned Aircraft System ('UAS') means an unmanned aircraft and the equipment to control
It remotely.

Autonomous operation means an operation during which an unmanned aircraft operates. without the remote pilot being able to intervene;

Normal flight envelope means the flight envelope associated with routine operations and prescribed conditions;

Operational flight envelope means the flight envelope associated with warning onset;

Limit flight envelope means the flight envelope that is set by the unmanned aircraft design limits;

Continued safe flight and landing mean that the U.A. can continue controlled flight and landing, possibly using emergency procedures, if applicable, without requiring exceptional remote pilot skills. Upon landing, U.A. damage may occur as a result of a failure condition;

Ancillary equipment means the equipment required for the safe operation of the U.A. that is not installed in the U.A. or the Command Unit and that is not part of the specified C2 Link and identified and specified in the type design of the UAS.

2.3. Analysis

Both authorities have different definitions in their respective airworthiness standards, which may produce different airworthiness requirements. For example, EASA uses continued safe flight and landing in their definitions in Light-UAS.2515 Electrical and electronic system lightning protection, Light-UAS.2520 High-Intensity Radiated Fields (HIRF) Protection. This requirement is not found in the FAA airworthiness requirements.

- It is important to note that EASA uses continued safe flight and landing or emergency

recovery. However, emergency recovery is not defined.
EASA uses different flight envelope definitions in which Stall is one consideration among many others. For example, EASA in the CRD states that flight envelope definition is adapted, and 2510 addresses expected operation. In addition, Light-UAS.2160 Vibration and buffeting Within the limited flight envelope, there must be no vibration or buffeting severe enough to interfere with normal control of the U.A. or the safety of the operation. However, no equivalent is found in the FAA airworthiness requirements.

FAA uses associated elements that are not part of the FAA certification process, and it is analyzed in a later state. The FAA argument is that the associated element may go through faster technological changes, and therefore, it is better to do an operational evaluation of them.

3. GENERAL COMPARISON OF FAA AND EASA PROCESSES

- Before analyzing the more technical differences, it is worth comparing the general processes in the USA and Europe concerning granting UAS flight approval.
- The table below (and subsequently explained in the following sections) addresses the generally related aspects covering
  - The nature of the approval process itself
  - The applicability
  - The type of requirements to comply with

Table 1 - COMPARATIVE ANALYSIS EASA/FAA

	FAA	EASA
General Approval Process	Type Certification	1. Voluntary Type Certification (for SAIL III-IV) 2. Required T.C. for SAIL V-VI 3. Specific Category Operational Flight Authorisation (SORA) - Design Verification (for SAIL IV, SAIL III [see note [*] below])
Applicability	a. C2 Link is enabling PIC to take contingency action. b. The kinetic energy of ≤25,000 Ft-lbs. c. Altitude ≤400ft AGL. d. No operations over open-air assemblies (over people: acceptable). e. No flight into known icing. f. Maximum of 20:1 aircraft-to-pilot ratio. g. Electrically powered engines.	a. Medium Risk (SORA SAIL III-IV) or High (SAIL V-VI) b. UA < 600 kg c. Operated with the intervention of the remote pilot (or autonomous but would need additional S.C.) d. One to One (One too many with additional S.C.s?)?
Requirements	Special Airworthiness Criteria (incl. D & R testing and additional requirements)	1. Light U.A. Special Condition (T.C.) - Medium with FTB MoC only for SAIL III, no FTB for SAIL IV 2. Light U.A. Special Condition (T.C.) - High, no FTB 3. SORA OSOs with correlated to Light UA SC requirements (Emerging JARUS SORA 2.5 proposes using FTB for SAIL II, III, and IV, which EASA may or may not further endorse.)

[*] Note: EASA "Declarative" MoC under preparation for SAIL III

3.1. FAA UAS REGULATION FOR CERTIFICATION OF LOW-RISK UNMANNED AIRCRAFT

This section begins with analyzing the FAA's current UAS regulations to later compare with EASA regulations. The FAA developed the framework for airworthiness criteria within the safety continuum using a Durability and Reliability (D&R) methodology to balance certification rigor with safety-related outcomes. These airworthiness criteria provide a set of requirements that the uncrewed Aircraft (U.A.) must meet to receive a type certificate under title 14, Code of Federal Regulations (14 CFR) 21.17(b). The safety data evidence is obtained by replicating realistic operational flight tests; the flight test hours depend on the CONOPS presented by the applicant. Table 2 shows a correlation between population density, hazard mitigation, and airspace. The table does not consider all the different variables the FAA uses to determine the risk category. Nonetheless, the latest certification basis issued by the FAA sheds light on the applicability, and thus, this paper uses this information to identify the corresponding SAIL level of the operations.

The FAA does not use the SORA methodology to establish the Risks and hazards associated with the operations. Thus, it is challenging to establish a direct correlation between SORA SAIL (Specific Assurance and Integrity Level, which dictates applicable requirements, including possibly Functional Test Based MoC) and the DNR process. However, it can be defined in a range of applicability and compared with EASA's current airworthiness standards for low-risk operations.

The FAA issued ten certification bases for different UAS OEMs and released policies and memorandums concerning the UAS certification process and applicability. In this section, we will use the applicability of the following documents to establish comparable risk levels associated with UAS operations.

- CPP-D&R-1.1, Certification Basis for Unmanned Aircraft Utilizing Durability and Reliability
- Docket No. FAA-2020-1086] Airworthiness Criteria: Special Class Airworthiness Criteria for the Amazon Logistics, Inc. MK27-2 Unmanned Aircraft
- Docket No. FAA–2022–0533] Airworthiness Criteria: Special Class Airworthiness Criteria for the Insitu Inc. ScanEagle3 Unmanned Aircraft
- [Docket No. FAA–2020–1085] Airworthiness Criteria: Special Class Airworthiness Criteria for the Matternet, Inc. M2 Unmanned Aircraft

CPP-D&R-1.1 establishes the following applicability criteria:

a. The UAS must have a command-and-control link that enables the pilot-in-command to take contingency action.

b. The U.A. must have a kinetic energy of ≤25,000 Ft-lbs.

c. The U.A. must be operated ≤400ft AGL.

d. No operations over open-air assemblies (operations over people are acceptable).

e. No flight into known icing.

f. Maximum of 20:1 aircraft-to-pilot ratio.

g. The U.A. must be electrically powered, excluding turbine engines and fuel cells.

Table 1 compares the applicability of CPP-D&R-1.1, Matternet, Scaneagle, and Amazon MK-27

Table 2 - APPLICABILITY ENVELOPE FOR DNR

CPP's Criteria	Matternet	Scaneagle	MK-27
C2 to enable PIC to take action in case of emergency	Yes	Yes	Yes
Aircraft Class	rotorcraft	fixed-wing airplane	powered lift uncrewed Aircraft
Weight (Pounds)	29	85	89
≤25,000 Ft-lbs[1]	Yes	Yes - 24,050	Yes
≤400ft AGL	Yes	**No - 3,500 AGL**	Yes
Operates over people	Yes	Yes	Yes
BVLOS	Yes	Yes	Yes
No Operation over assemblies	Yes	Yes	Yes
Rural/Urban	Suburban	Rural	Suburban
No FIKI	Yes	Yes	Yes
20:1	1:1	Note 1[2]	Note 1
electrically powered	Yes	**No, Internal Combustion engine**	Yes

Table one provides the entry criteria to define the risk range the FAA accepts under the DNR airworthiness standard. Then, it becomes easier to compare with EASA and identify if the safety continuum of both organizations is aligned.

Table two is part of the G-2 IP, which usually is an agreement between the FAA and the applicant. Table two contains the prescribed D&R test hours depending on the applicant's proposed CONOPS and aircraft injury probability. Only UA flight time can be counted toward meeting the D&R hour requirements under this means of compliance.

The FAA's Flight Standards Division defines the reliability category that must be met to operate in the environment corresponding to the applicant's proposed CONOPS. Flight Standards will

[1] Kinetic energy calculation depends on the aircraft class under consideration fixed-wing airplane, rotorcraft, powered-lift

[2] No information at this moment.

grant operating approvals based on these CONOPS and the demonstrations conducted during the U.A.'s type certification testing.

Applicants may get credit (reduction in prescribed test hours) if the U.A. presents a 30% or lower chance of causing an AIS (Abbreviated Injury Scale) level 3 or more significant injury. One FAA-accepted means, but not the only means, to meet this threshold is the incorporation of a parachute system that (1) meets ASTM F3322-18 Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes from the F38 Committee and (2) reduces the Aircraft's pre-impact kinetic energy **below 128 foot-pounds.**

- **Note:**
  - Unpopulated means are devoid of people
  - Sparsely populated means a population density of fewer than ten people per square statute mile in an area of at least one square statute mile.
  - A densely populated area means a census-designated place, as defined by the United States Census Bureau, with a population above 100,000 people or any area with a population density above 1,000 people per square statute mile and an area of at least one square statute mile[3]

Table 3 - RELIABILITY CATEGORY TABLE WITH POPULATION DENSITY

	Population density	Baseline	Reduced probability of injury configuration
	(People per square mile)	configuration (flight hours)	<30% AIS 3 or greater injury (flight hours)
RC A	Up to 100 (Rural)	375	150
RC B	Up to 3000	1100	540
RC C	Up to 7000	2500	1300
RC D	Up to 10,000	3600	1800
RC E	Up to 14,000	5000	2500
RC F	Up to 20,000	7200	3600

[3] Refer to (https://www.govinfo.gov/content/pkg/FR-2006-03-31/pdf/06-3137.pdf)

3.2. FAA CONOPS AND SORA SAIL RISK ACCEPTANCE RANGE

This section establishes the applicable SAIL for the FAA airworthiness standards, follow-risk operations, and current exemptions issued by the FAA.

The applicability of this airworthiness standard provides the entry criteria to be used in the SORA methodology. Annex 1 details establishing the adequate SAIL for the DNR airworthiness standard.

Per analysis of Annex 1, it is established that the SAIL is a range that potentially goes from SAIL II to SAIL IV.

This determination is essential in defining if the FAA and EASA safety continuum is comparable or substantially different.

3.3. EASA FLIGHT APPROVAL PROCESS

Several possibilities exist within the E.U. regulations to get a UAS Operational Authorization or Type Certificate in the medium Risk (SORA SAIL III-IV) or High-Risk Category (SORA SAIL V – VI)

- Voluntary Type Certification in the Medium Category based upon demonstration of compliance with Light UAS Special condition (Medium) requirements used as Type Certification Basis
- Required Type Certification for High Category based upon demonstration of compliance with Light UAS Special condition (High) requirements used as Type Certification Basis
- Specific Category Operational Authorization for SAIL III or IV based upon demonstration of compliance with SORA Operational Safety Objectives (with the relevant Level of Robustness) / Step#9 containment requirements and any applicable Ground or Air Risk Mitigation Requirements. A Design Verification Process (see note below) will be applied in this latter case, considering the established correlation between SORA OSOs and Light UAS Special Condition requirements.

Note: EASA is preparing Declarative Means of Compliance that could be used in the Design Verification required for SAIL III.

In addition, EASA has published an "FTB" Means of Compliance based on Functional Tests

- EASA proposes to utilize extensive evidence from functional tests as MoC for a significant subset of the Light UAS SC requirements (list provided in the FTB MoC, ref. (9)).
- However, the FTB approach is acceptable only for UAS operated in SAIL III and below. The FTB MoC states that the ATM standard ASTM F3478-20 may be used to define the FTB demonstration program.
- The maximum allowable rate of loss of control of the operation per flight hour (F.H.) is linked with the SAIL (10^{-SAIL}/h) and achieved by complying with Operational Safety Objectives (OSOs). It covers both operational and system reliability aspects.
- In statistics, the "rule of three" determines that if an event does not occur in the first n experiments, the maximum probability of its occurrence is 3/n with 95% confidence.

Therefore, for the scope of this MoC, the "event" is loss of control, the "experiment" is the flight hour, and the "probability of its occurrence" is the probability of loss of control per flight hour, which is linked with the SAIL.

- The overall nominal number of flight hours (F.H.) to be distributed across is 3000 FH for SAIL III
- In case a DVP is voluntarily applied for SAIL II, EASA would recommend the application of the FTB methodology, leading in this case to a DTP based on several F.H.s not exceeding 300 FH.

3.4. EASA FTB vs. FAA D&R – REQUIRED FT HOURS

Based on JARUS SORA 2.0 and draft JARUS SORA 2.5, EASA and the FAA hours are compared and establish the differences between both regulators.

3.4.1. Current EASA regulation based upon JARUS SORA 2.0

Reference (10) with related EASA (SORA based upon JARUS 2.0) AMC 1 to Article 11 of E.U. regulation 2019/947 is being used, at least to validate the comparison methodology. However, this AMC will likely be updated based on emerging JARUS SORA 2.5 (see next subsection).

Considering that for EASA only SAIL III operations can be demonstrated using FTB, with 3000 hours[4], the comparison has been performed between EASA FTB MoC and FAA D & R required flight test hours only in the case of SAIL III, considering parallel Ground Risk / Population Density and Air Risk.

As per SORA Step#7, SAIL III is only achieved with Final GRC = 4 and ARC a or ARC b:

Table 4 - SAIL DETERMINATION

SAIL determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C operation			

[4] The "rule of three" determines that if an event does not occur in the first n experiments, the maximum probability of its occurrence is 3/n with 95% confidence. For the scope of this MoC, the "event" is loss of control, the "experiment" is the flight hour, the "probability of its occurrence" is the probability of loss of control per flight hour, which is linked with the SAIL (10^{-SAIL}/h).

Operational scenarios leading to GRC = 4 are derived from the following table:

Table 5 - INTRINSIC GROUND RISK

Intrinsic UAS ground risk class				
Max UAS characteristics dimension	1 m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	>8 m / approx. 25 ft
Typical kinetic energy expected	< 700 J (approx. 529 ft lb)	< 34 kJ (approx. 25 000 ft lb)	< 1 084 kJ (approx. 800 000 ft lb)	> 1 084 kJ (approx. 800 000 ft lb)
Operational scenarios				
VLOS/BVLOS over a controlled ground area[3]	1	2	3	4
VLOS over a sparsely populated area	2	3	4	5
BVLOS over a sparsely populated area	3	4	5	6
VLOS over a populated area	4	5	6	8
BVLOS over a populated area	5	6	8	10
VLOS over an assembly of people	7			
BVLOS over an assembly of people	8			

Operational scenarios selected:

- 4 with GRC=4 /no mitigations
- 4 with GRC=4 after mitigation credit of -1 or -2

According to the above table, we have identified eight operational scenarios that could lead to Final GRC4 as presented in Annex 2, Table 10:

Case 1: iGRC = Final GRC = 4 (no mitigations)

(1) VLOS over the populated area / K.E. < 529ft-lbs

(2) BVLOS over sparsely populated area / K.E. < 25000 ft-lbs

(3) VLOS over the sparsely populated area / K.E. < 800000 ft-lbs (i.e., above FAA applicability K.E. threshold)

(4) VLOS/BVLOS above-controlled area / K.E.> 800000 ft-lbs (i.e., above FAA applicability K.E. threshold)

Case 2: Final GRC = 4 assuming mitigation credit of -1 or -2 starting from higher iGRC

(5) BVLOS above-populated area / K.E. < 529 ft-lbs - iGRC=5

(6) BVLOS above-populated area < 25000 ft-lbs - iGRC=6

(7) VLOS above populated area / KE < 80000 ft-lb - iGRC=6(i.e. above FAA applicability KE threshold)

(8) BVLOS above sparsely populated area / KE > 80000 ft-lb(i.e., above FAA applicability KE threshold)

The following differences in the comparison have to be emphasized:

- In the first evaluation stage, the comparison is made on generic criteria per available generic tables (FAA and EASA), considering the difference presented hereafter. In a second evaluation stage, by providing more input data (allowing to identify which columns of the iGRC are applicable, which EASA mitigation credit can be applied, and which ARC) are available on the three cases presented in Table 1.

- The EASA GRC table does only provide qualitative population density. In contrast, the FAA Reliability Categories (R.C.) are directly related to population density figures, which cannot be precisely correlated to the EASA categories of "sparsely populated" and "populated." The following correlation has nevertheless been made in the absence of additional information:
  - EASA "sparsely populated area" = FAA 100 – 3000 people/square miles (i.e., Reliability categories A or B – see table 2)
  - EASA "populated area" = FAA 3000 – 20000 people/square miles (i.e., Reliability categories C, D, E, or F – see table 2)
- In addition, the Ground Risk mitigation is "embedded" in the EASA SAIL determination (though the final GRC), which dictates in the case of SAIL III the required 3000 hours. In contrast, for FAA D & R, the Ground Risk mitigation allows for reducing the required F.T. hours.
- While FAA covers the entire range of K.E. below 25000 lb-ft, EASA introduces a lower range below 529 ft-lbs (see also Part 107 Subpart D Operations over human beings).
- No clear correlation exists between the operational scenarios and the U.A. maximum weight. It may, however, be assumed that the operational scenarios with K.E. exceeding 80000 ft-lbs [(4) and (8) in table 10 of Annex 2] and with K.E. between 25000 lbs and 80000lbs [(3) and (7) in table 10 of Annex] would likely correspond to UA weight exceeding 600kg. In these latter cases, EASA Light UAS SC would thus not be applicable nor the FTB MoC; therefore, the comparison cannot be made.

  Note: It may, however, well be that in the low K.E. range between 25000 lbs and 80000lbs, U.A. weight may still be below 600 kg, which means that Light UAS SC would still be applicable that FTB MoC (3000 hours) could be applied, whereas D & R testing may not.

Detailed comparison data are provided in the table in Annex 2, looking for the parallel FAA operational scenarios cases (applicable only for K.E. < 25000 ft-lbs), considering the Reliability category per quantitative population density.

The results of this comparison may be summarized as follows.

Table 6 - FAA AND EASA FLIGHT HOURS COMPARATIVE ANALYSIS

Item	(1)	(2)	(3)	(4)	(5)	(6)
	POPULATED				**SPARSELY POPULATED**	
EASA LOS & KE	BVLOS-VLOS & KE < 529 ft-lbs or BVLOS & 529 ft-lbs < KE < 25000 ft-lbs				BVLOS & 529 ft-lbs < KE < 25000 ft-lbs	
FAA KE	< 25000 ft-lbs				< 25000 ft-lbs	
FAA POD (people/sqm)	3000-7000	7000-10000	10000-14000	14000-20000	Up to 100	100-3000
FAA RC	C	D	E	F	A	B
FAA FT HOURS (NO MITIGATION)	*2500*	*3600*	*5000*	*7200*	*375*	*1100*
FAA FT HOURS (WITH MITIGATION)	**1300**	**1800**	**2500**	**3600**	**150**	**540**
EASA SAIL III FT HOURS	**3000**	**3000**	**3000**	**3000**	**3000**	**3000**

Significant differences are noted when comparing the EASA FTB MoC (SAIL III) requiring 3000 hours with FAA D & R required FT hours in various operational scenarios. Only above items (3) and (4) corresponding to BVLOS operations with a K.E. between 529 ft-lbs and 25000 ft-lbs, leading to Final GRC 4 with a Mitigation credit of -2 (e.g., with an approved parachute) can be considered as somewhat close in terms of required Flight Hours.

3.4.2. Review of current draft JARUS SORA 2.5

A draft updated JARUS SORA version 2.5 has been publicly released for public comments, and after the adjudication of comments and final update, it should be endorsed by EASA as an update SORA AMC 1 to E.U. regulation 2019/947 (envisaged target date Q1 2024)

Being aware that the comparison with current EASA SORA AMC 1 to E.U. regulation 2019/20247 will then become obsolete, it has also been decided to perform a comparison with the draft SORA 2.5 (in a first stage SAIL III, which may also be extended to SAIL II and SAIL IV later on).

The main SORA 2.5 changes relevant to this comparison are as follows.

(a) Introduction of quantitative criteria with a Target Safety Level of 10^{-6}/h for fatalities on the ground, whereas the probability of fatality is estimated as follows (Ground Risk):

$$10^{-SAIL}/h \times \text{Population density} \times \text{Critical area} \times \text{Kill probability } (=1)$$

(b) Subsequent update of the iGRC table considering now, in the vertical axis, population density values for each Class and in the horizontal axis U.A. maximal dimensions and maximal speed as follows:

Intrinsic UAS Ground Risk Class						
Max UA characteristics dimension		1 m	3 m	8 m	20 m	40 m
Max cruise speed		*25 m/s*	*35 m/s*	*75 m/s*	*150 m/s*	*200 m/s*
Maximum iGRC population density (ppl/km^2)	Controlled ground area	1	2	3	4	5
	< 25	3	4	5	6	7
	< 250	4	5	6	7	8
	< 2,500	5	6	7	8	9
	< 25,000	6	7	8	9	10
	< 250,000	7	8	9	10	11
	> 250,000	7	9	Category C Operations (Not part of SORA)		

Table 2 – Intrinsic Ground Risk Class (GRC) Determination

Figure 1 - SORA 2.5 Ground Intrinsic Risk

(c) Annex F (section 2.3) of the draft SORA 2.5 provides the detailed assumptions and calculations leading to a nominal critical area value for each of the above U.A. characteristics. It recognizes that these assumptions are likely conservative in the case of rotorcraft configuration (versus fixed wing) and may be revisited by the applicant. However, the applicant will normally not have to recalculate the critical area implicitly derived from the UA characteristics in the above iGRC table.

(d) The reduction of the ground risk class value due to VLOS operation was moved from the ground risk table to the M1 mitigation

(e) Mitigation M2 (e.g., parachute) has been updated to include the possibility of having up to 2 or 3 credits for the High / "High+" level of robustness (as defined in Annex E)

(f) Mitigation M3 (ERP) has been removed and is now considered a requirement

(g) Function Test Based approach is proposed for SAIL II (300 FT hours), SAIL III (3000 FT hours), and SAIL IV (30000FT hours)

Note: Kinetic energy is no longer an explicit parameter in the iGRC table (as in SORA 2.0). However, Annex F Table 13 does provide a correlation with U.A. weight that can be assumed for each combination of max U.A. dimensions and max cruise speed defining the vertical columns of the new iGRC table. Corresponding K.E. values may then be subsequently derived as follows:

Table 7 - U.A. MAX DIMENSION AND KINETIC E

U.A. max dimensions (m)	1	3	8	*20*	*40*
UA Max cruise airspeed (m/s)	25	35	75	*150*	*200*
Estimated Mass (kg)	3	50	400	*5000*	*10000*
Derived K.E. (kJ)	0.9375	30.625	1125	*56250*	*200000*
KE rounded value (kJ)	1	31	1130	*56000*	*200000*
ft-lb/J conversion	0.738	0.738	0.738	*0.738*	*0.738*
Derived K.E. (ft-lbs)	738	22878	833940	*41328000*	*147600000*

Based on the above table, a similar method has been used to perform the comparison in the case of SAIL III, looking for the possibility of getting GRC 4 without or with mitigation of -2. Hence, the following cases have been selected, as presented in Table 11 of Annex 3.

Case 1: iGRC = Final GRC = 4 (no mitigations)

(1) UA < 1 m, 25 m/s, and POD: 25-250 people/km^2

(2) UA 1 -3 m / 35m/s and POD < 25 people/km^2

(3) UA 8-20 m/ 150 m/s and POD 0 people/km^2

Case 2: Final GRC = 4 assuming mitigation credit of -2 starting from iGRC=6

(4) UA < 1 m, 25 m/s, and POD: 2500-25000 people/km^2

(5) UA 1 -3 m / 35m/s and POD 250-2500 people/km^2

(6) U.A. 3-8 m/ 75 m/s and POD 25-250 people/km^2

(7) U.A. 8-20 m / 150 m/s and POD less than 25 people/km^2

Note: Operational scenarios (3) and (7) correspond to a U.A. weight ranging from 400 to 5000 kg. Thus, only the lower part of this range with a U.A. weight of less than 600 kg could be compared.

- Looking at the parallel FAA operational scenarios cases (applicable only for K.E. < 25000 ft-lbs), considering the reliability category per RC-related quantitative population density values in the range of those of SORA 2.5 iGRC table, we obtain the comparison table provided on the next page.

One has to note an additional difficulty in this comparison since the range of FAA and draft JARUS SORA 2.5 population density values are quite different and intermix each other as illustrated hereafter, showing the FAA POD grouping together with EASA draft JARUS SORA 2.5 grouping:

TABLE 8 - FAA RC VS. SAIL CONSIDERING POD

POD range (ppl/sq-miles)	POD range (ppl/sq-km)	FAA RC A	JARUS 1	FAA RC B	JARUS 2	FAA RC C	JARUS 3	FAA RC D	JARUS 4	FAA RC E	JARUS 5	FAA RC F	JARUS 6
0	0												
65	25												
100													
648	250												
3000													
6477	2500												
7000													
10000													
14000													
20000													
64767	25000											N/A	
647668	250000											N/A	
	>250000											N/A	

Detailed comparison data are provided in Table 11 in Annex 3, looking for the parallel FAA operational scenarios cases (applicable only for K.E. < 25000 ft-lbs), considering the Reliability category per quantitative population density.
Significant differences are noted in terms of required F.T. hours; the only case that can be considered as having the same order of magnitude (2500 hours for FAA D& R and 3000 hours for JARUS draft SORA 2.5) is related to the operational scenario (4) [U.A. < 1 m, 25 m/s], including Ground Risk Mitigation, with a Population density between 14000 and 20000 ppl/sq-mile (i.e., between 5404 and 7720 ppl/km^2, thus within the JARUS SORA 2.5 range 2500-25000 ppl/km^2)

▪

In addition, Table 12 in Annex 3 compares concrete examples/study cases: Amazone MK-27, Matternet M2, and Airobotics OPTIMUS 1-EX using the UA characteristics and CONOPS data provided in the Federal Register. Potential significant differences also appear in terms of required Flight Hours.

4. EASA LIGHT SC UAS ("no FTB") VS. "PARALLEL" FAA D&R

- The purpose of this section is to perform a comparison between, on the one hand, those the EASA SC Light UAS requirements, which, according to EASA FTB MOC, cannot be shown to comply using the FTB as a Means of Compliance, and the other hand with "parallel" D&R requirements (if any) that are or are not related to D&R testing.
- Annex 5 provides a detailed comparison table with the following information:
    - Sequential item
    - EASA SC requirement ("no FTB") reference, title, and text
    - Correlated SORA OSO, Step#9 or M1/M2 mitigation means its Level of Robustness corresponding to SAIL III ref. (11)
    - "Parallel" D & R requirements (if any)
    - Comparison classification according to the following categories
        - 1. Similar except for some pure wording differences
        - 2. Minor technical differences
        - 3. Major technical differences
        - 4. No equivalent requirements have been found
    - Comments about the differences that have been noted

The following main differences (corresponding to classification 3 or 4) have been identified (referring to the related line item in the Annex 5):

- Items 6 and 7: Structural strength could be demonstrated by flight tests for FAA, which EASA does not accept (see EASA FTB MoC)
- Item 9: No Fire Protection requirements (as per EASA) are currently part of FAA requirements (except for Scan Eagle)
- Item 10: EASA does not require compliance demonstration for lightning as long no fatalities reasonably can be expected (non catastrophic effects). The loss of the UA in this case is accepted. The FAA requires compliance demonstration for lightning for the loss of the UA (loss of control) independent of fatalities and loss of flight, which could be according to EASA, catastrophic or noncatastrophic depending on fatalities. However, both accept operational limitations if exposure to lightning conditions is unlikely.
- Item 12: There is no direct equivalent to the EASA self-containment requirement in case of a forced/crash landing. The FAA requests a "safe termination," which could or could not contain a self containments requirement. EASA requests the self-containment for all forced/crash landing, independent of the reason. The FAA requires the safe termination option only in a C2 link problem.
- Item 13 (Transportation): Compliance demonstration at the EASA is based on the declaration. Supporting evidence may or may not be available. Compliance demonstration at the FAA requires testing.

- Items: 17, 18, 19, 23: For the "2510" requirement (Systems & Equipment functioning), EASA asks for a systematic analysis, where FAA accepts the compliance demonstration by testing. Cybersecurity requirements are similar; however, EASA requests a security risk assessment, while the FAA requirement does not seem to require it formally.
- Item 21: EASA covers the design of all mitigation means, whereas the FAA covers only a parachute. Related to the parachute, both agencies referring to the ASTM standard F3318. Refer also to the EASA MoC to CS Light-UAS.2512, recently published
- Item 24: No equivalent FAA requirement regarding HIRF protection has been identified.
- Item 25: The intent of the EASA Navigation requirement is implicit in the FAA requirements, which are, however, not explicitly stated
- Item 26: No comparable requirement to EASA one has been formally identified in the FAA D&R regarding Command Unit HMI.
- Items 29, 31: Similar intent regarding information to be presented to the Remote Pilot to ensure safe operation; however, quite different wording that makes the comparison more difficult

5. CONCLUSION

Based upon the currently available materials, this document has presented a factual comparison between EASA and FAA approaches regarding the process and criteria leading to UAS Type Certification and Operational Authorization.

Being that both EASA and FAA are still finalizing their rules (EASA to endorse draft SORA 2.5 only after ongoing disposition of comments, FAA revisiting some of the rules that have been previously published), it shall be considered as a factual comparison based upon the existing material and as an attempt to illustrate the potential significant standard differences that may arise from the two approaches.

Both use a quantitative Target Level of Safety (TLOS) approach for ground risk. However, the different ways to establish parameters and calculate them (such as loss of control probability, critical area calculation, an account of population density range, Reliability Category versus Specific Assurance Integrity Level, and possibly additional factors) may explain those differences.

At this stage, lacking FAA inputs still under internal review that would parallel those provided in JARUS draft SORA 2.5, it has yet to be possible to investigate the reasons behind those differences fully. Annex 4 constitutes, however, a preliminary analysis.

This White paper will thus be put on hold pending the finalization of the FAA and EASA rule-making process.

As a preliminary finding, this is a summary of the differences covered in this white paper:

- Definitions in section 2
  - Differences in definitions may introduce significant differences in requirements.
- FAA DNR and EASA FTB applicability sections 3 and 4 shows
  - EASA FTB covers only SAIL III; FAA D&R covers SAILs up to SAIL IV

- FAA limited to 25000 ft-lbs (no limitations for EASA except 600 kg MTOW)
- Ground Control mitigations
  - EASA and FAA use risk mitigation, such as parachutes, differently. Both authorities give credit to it. However, the credit is given
    - The FAA reduces hours to half when using a parachute on the reliability category table, whereas JARUS SORA 2.5 requires obtaining a factor of 10 to reduce the SAIL in one.
- The apparent great disparity in required F.T. hours for SAILIII
  - EASA FTB: 3000 hours
  - The FAA D& R may vary from 150 to 7200 hours!
- EASA FTB covers SAIL III only
  - Flight testing does not cover all regulations as an applicable MoC.
- EASA SC Light UAS covers more operational scenarios than FAA DNR since DNR applicability is defined per the kinetic energy (25,000 foot-lb)
- Emerging JARUS / EASA SORA 2.5 may provide further elements of comparison for SAIL II, III, IV

- Section 4 has provided a comparison EASA and the FAA rule by rule to establish differences in requirements not covered by FTB in the EASA SC and has established that some requirements may bear significant differences.
  -

It is important to highlight that both authorities use different logic to group UAS operations in a safety continuum. The criteria for creating the groups are different:

1. EASA uses SAIL, a derivative of Ground Risk and Airspace Risk.
2. FAA uses Kinetic Energy, but the connection with population density is not defined in the FAA CPPs. The FAA's relationship to Airspace risk does not appear on the CPPs

Note: The FAA ARAC UAS committee provided recommendations not analyzed in this paper. After the FAA analyses them during the rule-making activities, these recommendations could bring potential changes to the rules, the creation of a new 14 CFR Part, or changes to airworthiness standards.

6. ANNEX 1 FAA APPLICABILITY AND SORA SAIL

6.1 Step #1: CONOPS description

The CONOPS is established in section 3.2 of this document using the DNR applicability table 1.

6.2 Step #2: Determination of the UAS intrinsic Ground Risk Class (GRC)

One of the first criteria to be used in SORA is the kinetic energy of the U.A. In its applicability, the FAA establishes that the U.A. must have a kinetic energy of ≤25,000 Ft-lbs. The second criterion is the operation scenarios; the DPP, ScanEagle certification basis, Amazon MK-27, and Matternet provide various operational scenarios.

Matternet and Amazon MK-27 are operations in BVLOS over a populated area, whereas ScanEagle operates in BVLOS over sparsely populated areas.

Figure one shows the range of possible IGRC concerning the envelope of possible operational scenarios approved by the FAA.

Intrinsic UAS ground risk class				
Max UAS characteristics dimension	1 m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	>8 m / approx. 25 ft
Typical kinetic energy expected	< 700 J (approx. 529 ft lb)	< 34 kJ (approx. 25 000 ft lb)	< 1 084 kJ (approx. 800 000 ft lb)	> 1 084 kJ (approx. 800 000 ft lb)
Operational scenarios				
VLOS/BVLOS over a controlled ground area[18]	1	2	3	4
VLOS over a sparsely populated area	2	3	4	5
BVLOS over a sparsely populated area	3	4	5	6
VLOS over a populated area	4	5	6	8
BVLOS over a populated area	5	6	8	10
VLOS over an assembly of people	7			
BVLOS over an assembly of people	8			

Figure 2 - SORA Intrinsic Ground Risk Class (IGRC) for the DNR

2≤ IGRC ≤ 6 – For clarity, the calculations done herein are considering only IGRC = 6

6.3 Step #3: Final GRC determination

The final ground risk is defined by considering the following criteria:

1) High robustness since it is evaluated through a certification process by a recognized international authority
2) The FAA recognizes the use of parachutes to reduce the reliability category as defined in Table 2.
3) If we consider a BVLOS operation over people, strategic mitigations are

		Robustness		
Mitigation Sequence	Mitigations for ground risk	Low/None	Medium	High
1	M1 — Strategic mitigations for ground risk[21]	0: None -1: Low	-2	-4
2	M2 — Effects of ground impact are reduced[22]	0	-1	-2
3	M3 — An emergency response plan (ERP) is in place, the UAS operator is validated and effective	1	0	-1

Figure 3 - Final Ground Risk Class (FGRC)

Then, per Figure 3, the FGRC can be between 3 ≤ FGRC ≤ 5

It can be three since the Aircraft uses a parachute, and five if it is only considered an emergency response plan.

6.4. Is the GRC less than YES Step #4 or equal to 7?

Yes

6.5. Step #4: Determination of the initial Air Risk Class

The three Aircraft under consideration present different types of tactical and strategic mitigations. This paper will not analyze them. It will only consider the airspace class in which they operate.

Table 3 summarizes the airspace class in which Matternet, Amazon MK-27-2, and ScanEagle operate.

Table 9 - OEM comparative analysis

	Amazon MK27-2	Matternet	ScanEagle
Controlled	X (Note 1)		
Uncontrolled	X (Note 1)	X (Note 2)	X (Note 3)

The operations are starting in uncontrolled airspace; however, the petitions for exemptions presented by Amazon provide states in note 1b that operations will be carried out in controlled airspace. Amazon's petition for exemption must clearly state the airspace class on which it will operate as defined by Matternet UPS exemption. Thus, some assumptions are needed for this section to achieve the SAIL number's derivation. The FAA will validate this assumption.

1) The FAA allows no operations in airspace class A or B.
2) Operations in Class C within mode C-Veil are allowed

Note:

1) AMAZON MK27-2
    a. The FAA concludes that Amazon's compliance with the conditions and limitations of this exemption, along with the FAA's safety evaluation of the MK27 UAS, will enable Amazon's operations using the MK27 UAS without adversely affecting safety. Amazon is currently engaged in the process of receiving a type certificate for the MK27 UAS utilized in its operations. Current operations are in Lockeford, California, and College Station, Texas.
    b. Prime Air will implement operational rules that conform to airspace access requirements and provide for the exchange of safety-critical flight information with ATC and with other airspace users. Our operations will be conducted in both **controlled and uncontrolled airspace** and below 400 feet AGL unless temporary deviations are necessary for safety.
2) Matternet M2 and UPS exemption
    a. Matternet has obtained the FAA-type certification for M2. TYPE CERTIFICATE DATA SHEET No. R00030LA
        i. TCDS NOTE 10 Operations of this Aircraft over human beings are prohibited unless the FAA approves such operations. (i.e., 14 CFR 107.140)
    b. Current UPS FF routes are flown at a minimum altitude of 300 feet AGL and a maximum altitude of 400 feet AGL in Class G airspace, with take-off and landing phases flown in vertical profiles to ensure obstacle clearance. The minimum profile altitude ensures full deployment of the emergency parachute if activation of the Matternet M2 sUA FTS is required. The maximum Altitude on the proposed routes provides separation from manned Aircraft normally operating at or above 500 feet AGL (1,000 feet AGL over congested areas).
    c. UPS FF flights are conducted at or below 400 feet AGL and do not currently operate within Class B, C, or D airspace. However, following UPS FF procedures, telephone voice contact may be established with any required entities (e.g., helipad operators) identified in the safety analysis and risk assessment process for hazard mitigation.
3) ScanEagle – Operational Boundaries
    a. Scaneagle3 operations will cover less populated areas or bodies of water. Therefore, flight paths will avoid flight over population centers.
    b. Scaneagle will operate in the airspace appropriate for the mission: Class B, C, E, F & G. However, Instu will apply appropriate mitigations to minimize airspace conflicts. Insitu follows a comprehensive process to understand the airspace users and

implements a communication plan and operation risk mitigation plan to deconflict airspace users.

c. No Class A airspace is planned.

Figure 3 provides the initial ARC. Per the notes above, it is determined that the dashed blue shape offers a summary of the possible operations the Aircraft under study can operate.

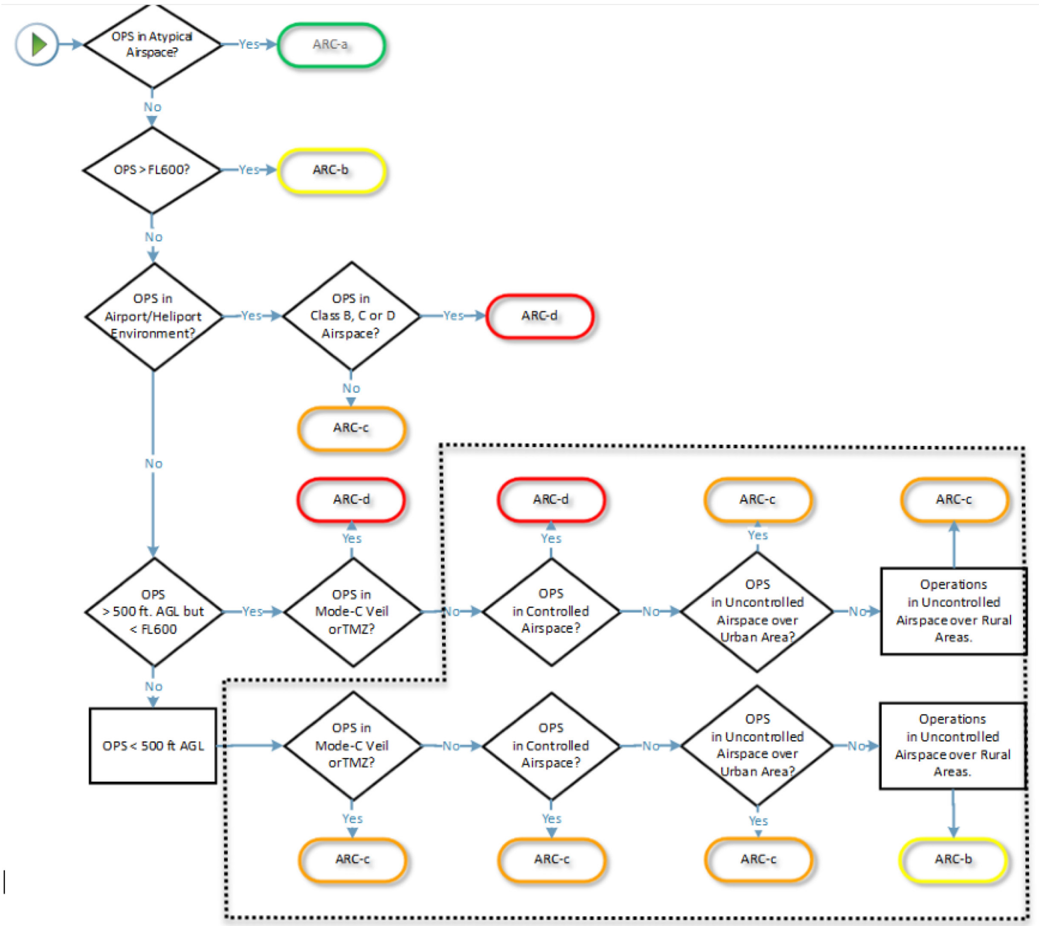

Figure 4 – ARC assignment process

Figure 4 - Initial ARC

6.6 Step #5 (optional) and Step #6

Step 5 and Step 6 are not developed in this document since it is optional to establish the final possible SAIL number, and details on the implementation of the CONOPS of the OEM under study are unavailable at the moment of this analysis.

6.7 Step # 7: SAIL determination

Step 3 defines that the FGRC is between 3 ≤ FGRC ≤ 5; step 4 determines that the ARC is between ARC B and D. Consequently, the red square in Figure 5 provides the intersection of Residual ARC and FGRC.

SAIL Determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C operation			

Figure 5 - SAIL determination

Therefore, the FAA DNR airworthiness standard and exemptions provide that current SAIL may be between II ≤ SAIL ≤ VI

7. ANNEX 2: FAA D&R VS EASA FTB / SORA 2.0 REQUIRED FT HOURS

Refer to section 3.4.1, which introduces Table 10 on the following page.

Table 10 - CURRENT EASA SORA VS. FAA DNR FLIGHT HOURS

	Current EASA SORA (2.0)							
	SAIL III POSSIBILITIES (FTB 3000 hours) - GRC to be 4, ARC may be a or b (see Step#7 SAIL = f(GRC, ARC))							
	U.A. Maximum dimensions							
	1m	3m	8m	>8m	1m	3m	8m	>8m
	U.A. K.E. / Population density (qualitative)							
	(1)	(2)	*(3)*	*(4)*	(5)	(6)	*(7)*	*(8)*
	< 529 ft-lb - VLOS above a populated area	< 25000 ft-lb BVLOS above a sparsely populated area	*< 80000 ft-lb VLOS above a sparsely populated area*	*> 80000 ft-lb BVLOS/VLOS above-controlled ground area*	< 529 ft-lb - BVLOS above a populated area	< 25000 ft-lb BVLOS above a populated area	*< 80000 ft-lb VLOS above a populated area*	*> 80000 ft-lb BVLOS above a sparsely populated area*
iGRC = Final GRC (no mitigation)	**4**	**4**	***4***	**4**				
iGRC		5			5	6	*6*	*6*
Mitigation		-1			-1	-2	*-2*	*-2*
Final GRC		**4**			**4**	**4**	***4***	***4***
	FAA D & R							
	U.A. K.E. < 25000 ft-lb / Equivalent Population density (quantitative)							
Population density (ppl / mile^2)	*3000 - 20000*	*100 - 3000*	*N/A*	*N/A*	*3000 - 20000*	*3000 - 20000*	*N/A*	*N/A*
Population density (ppl / km^2))	*1160-7722*	*39-1160*			*1160-7722*	*1160-7722*		
RC	*C-F*	*A-B*	*N/A*	*N/A*	*C - F*	*C - F*	*N/A*	*N/A*
D & R flight hours (no mitigation)	*2500 - 7200*	*375 - 1100*	*N/A*	*N/A*	*2500 - 7200*	*2500 - 7200*	*N/A*	*N/A*
D & R flight hours with mitigation	*1300 - 3600*	*150 - 540*	*N/A*	*N/A*	*1300 - 3600*	*1300 - 3600*	*N/A*	*N/A*

8. ANNEX 3: FAA D&R VS DRAFT SORA 2.5 REQUIRED FT HOURS

Refer to section 3.4.2, which introduces Table 11, presented hereafter

Table 11 - JARUS DRAFT SORA 2.5 VS. FAA DNR FLIGHT HOURS

	Draft JARUS SORA (2.5)						
	SAIL III POSSIBILITIES (FTB 3000 hours) - GRC to be 4, ARC may be a or b (see Step#7 SAIL = f(GRC, ARC))						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Max UA dimensions / cruise speed - Estimated Mass / KE (Annex F table 13)						
	<1m /25 m/s <3 kg (738 ft-lbs)	1-3m/35m/s 3-50 kg (22878ft-lbs)	*8-20m/150m/s 400-5000 kg (833940 ft-lbs)*	<1m /25 m/s <3 kg (738 ft-lbs)	1-3m /35 m/s 3-50 kg (22878ft-lbs)	3-8 m / 75 m/s 400 kg (833940 ft-lbs)	*8-20m/150m/s 400-5000 kg (41328000 ft-lbs)*
	Population density values						
	25-250 ppl/sq-km (65-648 ppl/sq-mile)	< 25 ppl/sq-km (< 65 ppl/sq-mile)	0 ppl/sq-km (0 ppl/sq-mile)	2500-25000 ppl/sq-km (6477-64767 ppl/sq-mile)	250-2500 ppl/sq-km (648-6477 ppl/sq-mile)	25 - 250 ppl/sq-km (65-648 ppl/sq-mile)	< 25 ppl/sq-km
iGRC = Final GRC (no mitig.)	4	4	4				
iGRC				6	6		6
Mitig.				-2	-2		-2
Final GRC				4	4		4
	FAA D & R						
	UA KE < 25000 ft-lb / Equivalent Population density (quantitative)						
FAA table parallel population density values (ppl / mile^2) as per RC table	*< 100 100-3000*	*< 100*	*N/A*	*300-7000, 7000-10000 1000-14000 14000-20000 > 20000 N/A*	*100-3000 3000-7000*	*< 100 100-3000*	*N/A*
RC	*A B*	*A*	*N/A*	*B C D E*	*B C*	*A B*	*N/A*
D & R flight hours (no mitig.)	*A:375 B:1100*	*375*	*N/A*	*B:1100 C:2500 D:3600 E:5000*	*B:1100 C:2500*	*A:375 B:1100*	*N/A*
D & R flight hours with mitig.)	*A:150 B:540*	*150*	*N/A*	*B:540 C:1300 D:1800 E:2500*	*B:540 C:1300*	*A:150 B:540*	*N/A*

Table 12 - THREE STUDY CASES

UAS	Max Dimensions (m)	Max Speed (m/s)	MTOW (kg)	US CONOPS						JARUS SORA 2.5 PARAMETERS AS PER US CONOPS					
				Overflown population density (quant.) (pp/sq-m)	**Overflown population density (quant.) (pp/km^2)**	**Airspace flown**	**R.C.**	**D & R Flight Hours**	**Comments**	**iGRC**	**FGRC**	**ARC**	**SAIL**	**FTB FT hours**	**Comments**
Matternet M2	1.40	18.0	30.0	13	5	in Class G airspace at or below 400 feet above ground level (AGL), BVLOS	A	**150**	Parachute Recovery System ASTM F3222-18	3	1	b	II	**300**	iGRC first column (close to 1m, see also Annex F KE close to 2000) GRC credit -2
Airobotics Optimus 1-EX	1.78	13.9	25.0	Up to 3000 (in line with RC B)	250-2500	Max alt. 400 ft, Uncontrolled Airspace, BVLOS	B	**540**	Approved Parachute System	6	4	c red. to b (*)	III	**3000**	iGRC = 6 by using the first column (considering Low KE) , M2 mitigation (parachute) reducing iGRC by 2, thus Final GRC = 4 *(*) ARC could be reduced from ARCc to ARC b if credit may taken from the Visual Observers (Airspace Observers) making sure no Air Traffic in all areas of operations (see EASA PDRA-G01)* *If no ARC reduction, SAIL would IV and FT hours 30000h!*
Amazone MK-27	1.98	30.9	40.4	13	5	both controlled and uncontrolled airspace and below 400 feet AGL	RC A / RC B	**150 / 540**	Yes	6	4	c b	IV III	**30000 (*)** **3000**	(*) Considered in SORA 2.5, would likely require full TC in EASA iGRC 2nd column GRC credit -2 (if parachute confirmed) ARC b / SAIL III if Air Risk Mitigations accepted (low alt. to "avoid flying objects"?)

9. ANNEX 4 - Ground risk calculation FAA and EASA (SORA 2.5)

Both authorities use Equation 1 to determine the ground risk. $CapTLOS = \lambda LOC * (Dpop * Fexp * AC)\, P(Fatality/collision, LOC)$ Equation 1

Where:

- **TLOS**: is the expected level of safety
- **λLoc**: the expected number of times the UAS operation enters into a loss of control state per flight hour. This parameter takes into account both the Aircraft's technical as well as operational failures.
- **Dpop**: is the maximum assumed population density within the ground risk footprint
- **Fexp:** is the fraction of people exposed to harm from the operation, equivalent to (1 - sheltering factor).
- **A.C.:** is the critical area of the Aircraft, which is the ground area where a person would be expected to be impacted by the Aircraft in the event of a loss of control, even
- **P(fatality|collision, LOC)** is the probability of the UAS causing a fatality to each impacted person because the Aircraft has failed into a loss of control state and collided with that person(s).is $Npeople = Dpop * Fexp * AC$

Where Npeople: the expected number of people the UAS collides with during a loss of control event considering evenly distributed in the area.

Finally, equation 3 is $TLOS = \lambda LOC * Npeople * P(Fatality/collision, LOC)$

This annex will explore each term of the Equation and compare the FAA and EASA position.

9.1. TLOS History

1) This section addresses the regulatory objective of ensuring that the accident rate per aircraft category does not rise with the introduction of RPAS.
2) AC-23.1309 1E states that: In assessing the acceptability of a design, it is recognized need to establish rational probability values. Historical evidence indicates that the probability of a fatal accident in restricted visibility due to operational and airframe-related causes is approximately one per ten thousand flight hours or 1 x 10-4 per flight hour for single-engine airplanes under 6,000 pounds. Furthermore, from accident databases, about 10 percent of the total was attributed to failure conditions caused by the airplane's systems. Therefore, it is reasonable to expect that the probability of a fatal accident from all such failure conditions would not be greater than one per one hundred thousand flight hours or 1 x 10-5 per flight hour for a newly designed airplane. From past service history, it is also assumed that about ten potential failure conditions in an airplane could be catastrophic. The allowable target average probability per flight hour of 1 x 10-5 was thus apportioned equally among these failure conditions, which resulted in an allocation of at most 1 x 10-6 to each. The upper limit for the average probability per flight hour for catastrophic failure conditions would be 1 x 10-

6, establishing an approximate probability value for the term 'extremely improbable.' Failure conditions having less severe effects could be relatively more likely to occur. Similarly, airplanes over 6,000 pounds have a lower fatal accident rate and probability value for catastrophic failure conditions.

3) RPAS.1309 states, "At the time of writing, no manned Part-23 aircraft has been certificated with complex fly-by-wire flight control systems. If such an application were to be made, it would be reasonable for the authorities to raise the number of potentially catastrophic failure conditions by one order of magnitude. While it is accepted that Complexity Level I RPAS will have less complex systems, this cannot be said for Complexity Level II RPAS. It is, therefore, reasonable to assume that Complexity Level II RPAS containing complex airborne electronic hardware and software may have an order of magnitude of one hundred potential failure conditions regardless of the category of RPAS."
4) One of the safety principles is that any new technology should maintain an equivalent to the current level of safety. Thus, JARUS RPAS.1309 states, "a value of 1x10-4 pfh should be established as a minimum target accident rate for those RPAS for which no equivalent manned Aircraft exists. The rationale is based on maintaining the overall fleet accident rate close to that of manned Aircraft.
5) RPAS.1309 Table 2 provides a breakdown of the methodology used to define the target level of safety.

Table 13 - TARGETED LEVEL OF SAFETY COMPARATIVE ANALYSIS

Example Aircraft Type	RPAS Complexity Level	Accident Rate (pfh)	10% Due to Systems	No. of Potential Catastrophic failure conditions	Probability of a Catastrophic Failure Condition (pfh)
Manned CS-23 class I	N/A	$1x10^{-4}$	$1x10^{-5}$	10 (10^{-1})	$1x10^{-6}$
RPAS CS-23 class I	CL I	$1x10^{-4}$	$1x10^{-5}$	10 (10^{-1})	$1x10^{-6}$
	CL II	$1x10^{-4}$	$1x10^{-5}$	100 (10^{-2})	$1x10^{-7}$
CS-LURS	CL I	$1x10^{-4}$	$1x10^{-5}$	10 (10^{-1})	$1x10^{-6}$
	CL II	$1x10^{-4}$	$1x10^{-5}$	100 (10^{-2})	$1x10^{-7}$

9.2. FAA's TLOS and Reliability Categories

Mitre took the NTSB baseline risk for people on the ground from Part 23 operations and used it to identify the loss of control rate. So, when you have a light aircraft flying standard operations, the NTSB has found that the Risk to people on the ground is roughly 5* 10-7.

So, Mitre took that, and the FAA applied it to a wide range of population densities, factoring in the operating **A**ltitude, the speed, and the kinetic energy of these various **A**ircraft to come up with several hours and with safety factors built in so that if you fly these numbers of hours, the ground risk is never going to be higher than 5*10-7 for any given individual in that area refer**s** to table 2 in this document.

As the FAA analy**z**ed the data, one thing that came up was som ething like parachutes, the assumptions made to come up with the baseline configuration, hours assumed a fatality for any impact, whether it hits somebody in the head or toe. **But, s**till, it came up that if somebody chooses to put in a system to reduce the kinetic energy of their **A**ircraft significantly or to, in some other way, reduce the likelihood of a fatality, we should be able to take credit for that.

We want to ensure that there is an incentive for applicants to do such. So, this last category, that reduced probability of injury, is meant to describe the fact that not only are they operating in areas where there is only a specific population density beneath them or population density equivalent in this case. But even **if there is a failure, mitigating features** reduce the likelihood of fatality over what the baseline configuration would expect. And because they are mitigating that Risk and other ways, fewer hours are needed; the reliability doesn'**t** need to be as high because the likelihood of a fatality when one of these comes down is reduced.

Mitre seems to have done similar calculations as done in Table 13 and retains the fact that there is an increase in the level of complexity as stated by RPAS.1309 due to the use of fly-by-wire and increased TLOS in a magnitude of order.

9.3. EASA's SORA 2.5 TLOS

SORA 2.5 Appendix F states as follows:

- $TLOS = \lambda GAAccident \cdot Nfatality|GAAccident)$
  Where:
  - λGAAccident is the generally accepted manned general aviation accident rate. Annex F uses 10−4 accidents per flight hour for general aviation, as discussed in section 11.3(c) of the Scoping and
  - Nfatality|GAAccident is the expected ground fatalities per general aviation aircraft accident. Annex F uses 10−2 fatalities per manned G.A. accident rate, as discussed in section 11.2(c) of the RPAS.1309 Scoping Paper.
  - Then, Multiplying out the terms in Equation (1) provides a value of 10−6 fatalities per flight hour (or one fatality every 1 million flight hours), which UAS operations should not exceed. It is highlighted, however, that the TLOS detailed above for G.A. is the Risk to third parties on the ground and does not include the Risk to people on board the Aircraft.
  - The TLOS does not consider the system's increased complexity level, as Table 2 of RPAS.130 states. Then, TLOS considers a G.A. aircraft that considers only ten critical failure conditions. These UASs will have higher critical failures since, for example, they uses fly-by-wire

9.4. MTBF – MEAN TIME BETWEEN FAILURE

The probability of the vehicle failing to maintain flight control (λLoc) represents the likelihood that it behaves in a manner that was not intended. This may be due to loss of the control link between the ground station and the sUAS, component failure or damage to the sUA, or loss of flight for other reasons. This probability is primarily dependent on the failure rate expressed as MTBF.

Then, λLoc could be associated with MTBF. Utilizing MTBF enables the **E**quation to calculate the probability of the vehicle failing and**,** thus**,** the Risk of it striking a third party. MTBF can be derived from many methods, such as analyzing the results of extensive flight testing or using a component failure model that captures the failure rate of key components (as specific model data is generally proprietary).

9.5. FAA's λLoc

- Currently, the FAA has not provided information concerning how λLoc is calculated. However, it can be inferred that the reliability categories are defined as follows $\frac{TLOS}{Npeoople\ P(Fatality/collision, LOC)} = \lambda LOC$ Equation 3

$\frac{1}{\lambda LOC} * Safety\ Factor\ = Flying\ hours$ Equation 4

- Equation 3 shows the loss of control per hour, and Equation 3 shows the flying hours expected to demonstrate that the Aircraft is within the confidence interval.
- The FAA discretized a continuum equation as done by EASA; however, the ranges, such as population density and critical area, differ. Unfortunately, no further information is public on how the FAA has done its discretization.
- Also, there is no information on how the FAA considers airspace in the definition of reliability category.
- Note:
  - Discretization is the process through which transform continuous variables, models, or functions into a discrete form. It is done by creating a set of contiguous intervals (or bins) across our desired variable/model/function range. This process is usually carried out as a first step toward making them suitable for numerical evaluation and implementation.
  - Discretization aims to reduce the number of values a continuous variable assumes by grouping them into a number, b, of intervals or bins. Two key problems associated with discretization are selecting the number of intervals or bins and deciding on their width. Thus, the main disadvantage of discretization is the loss of information in the process, which can potentially reduce the performance of classifiers if the information loss is relevant for classification.
- The authorities would have arrived at similar results using the same Equation to meet the TLOS. However, they have used different discretization methods.

9.6. EASA's λLoc and relation to SAIL

Per Jarus SORA Appendix F, With no further action, the iGRC becomes the final Ground Risk Class (GRC) and would be assigned a SAIL, which maps the loss of control rate to operational, organizational, personnel, and technical threat barriers that, when implemented correctly at the SAIL level required, provides the requisite assurance that the maximum probability of loss of control for an operation will be below the loss of control rate required to meet the TLOS. Figure 6 and Figure 7 provide loss of control per flight hours and the flight test hours needed to demonstrate a safe operation. SORA uses and normalizes the grouping around a factor of 10

SAIL level	I	II	III	IV	V	VI
operation failure rate λ_{LOC} (Probability of loss of control per flight hour)	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}

Figure 6 - SAIL LEVEL RELATION TO LOSS OF CONTROL

Applying the rule of three, n statistical analysis states that if a certain event did not occur in a sample with n subjects, the interval from 0 to 3/n is a 95% confidence interval for the rate of occurrences in the population. Per FTB MOC SC Light-UAS Issue 1 states, "For the scope of this MoC, the "event" is loss of control, the "experiment" is the flight hour, the "probability of its occurrence" is the probability of loss of control per flight hour, which is linked with the SAIL as per footnote 2 (footnote2: 10-SAIL / F.H.)"

The final SAIL is defined by taking the larger air and ground risk contribution.

The light hour considering the rule of three is as follows

SAIL Level	SAIL I	SAIL II	SAIL III	SAIL IV	SAIL V	SAIL VI
Flight Hours	30	300	3,000	30,000	300,000	3,000,000

Figure 7 - RULE OF THREE

There is not a direct relationship between the flying hours and equation 3. Therefore, it has been bin into integers using a factor of 10 considering population density and 10 concerning flying hours. Sora 2.5 Appendix page 21 states, "It is important to note that the nominal population and critical area values in Table 5 produced integer iGRC values, purely because when multiplied they produce multiples of 10. However, many other real-world combinations lead to non-integer RAW iGRC scores. This is an important consideration as the population can vary widely, as can critical areas. Notably, our analysis to identify suitable critical areas given wingspan, velocity, and many other variables, resulted in very different values to those provided in Table 6" As defined by Appendix F, it is known the loss of granularity (information using this method."

Appendix F, Page 22, states that scrutiny of the bottom right-hand corners for each cell reveals the maximum iGRC score in the cell is one integer larger than the allocated values shown in Table 2. For example, for the iGRC-4 quanta in the second column, it can be seen that a small portion of the iGRC-5 exists in that corner. While **a simple policy rounding up all raw scores would maximize safety**, this is considered overly conservative, representing a relatively small percentage of operating scenarios in each cell. That is because an increase by one integer iGRC value coincides with an order of magnitude difference. Accordingly, a more practical and balanced policy was adopted such that the product of population and critical area can be up to 2 times larger than the nominally allowable values producing integer iGRCs, and it will still be rounded down. All other permutations resulting in a product above two but less than ten are rounded up."

9.7. Population Density

Population density is one of the most important factors in a risk assessment because it describes people involved in a UAS accident. Higher population density leads to a proportionally higher operational risk.

Per JARUS Appendix F and the FAA, the risk assessment for a UAS is based on static statistical data to analyze ground risk, not considering the spatial-temporal characteristics of people density. Thus leading to a difference between the assessed Risk and actual Risk during operations.

Population density is dynamic. Therefore, accurate population density predictions are required to improve risk assessment. Spatial-temporal population density data has the following characteristics

- Temporal characteristics, including closeness, trend, and period components
  - For example, people spend 93% of their time in shelters
- spatial characteristics, including nearby and distance components.

Thus, it is important to distinguish pedestrian density and population density. Population density, usually obtained from census data, is a count of where people live and sleep; pedestrian density is where people are located during the intended sUAS operation.

The risk assessment can also apply a shelter factor to the pedestrian density for increased accuracy. For example, according to the U.S. Census, a dense urban residential area may officially have 10,000-15,000 people per square mile. However, a small percentage of people will likely be outside, and a large percentage will be sheltered inside buildings, thus protected from impact. On the other hand, an sUAS does not typically have enough energy or Mass to penetrate a typical structure, so people indoors are not considered at Risk. To factor in these variations, the model uses a shelter factor to calculate exposed pedestrians at Risk.

9.8. FAA Population Density

The FAA first established a maximum population density and then used a weighted population density average for the approvals.

Note: Weighted average is a calculation considering the varying degrees of importance of the numbers in a data set. In calculating a weighted average, each number in the data set is multiplied by a predetermined weight before the final calculation is made.

Furthermore, it is also needed to consider the FAA in the population density using Table 12. Although the FAA does not use a factor of ten, the bins are smaller. Refer to Figure 6, which compares the FAA and EASA bin methodology.

FAA per square km	EASA per square km
Up to 38.61	25
Up to 1158.3	250
Up to 2702.7	2500
Up to 3861	25000
Up to 5405	250,000
Up to 7722	Higher than 250,000

Figure 8 FAA and EASA different bins for population density

9.9. EASA Population Density

SORA 2.5 Appendix F section 3.1.2 uses the maximum population density. It also states, "Many applicants have historically sought to employ the averaging effect embedded within Approaches 1 and 2, employing arguments drawn from Appendix 3 of FAA AC 23-1309 [8] drawing on its use of "average probability per flight hour" as the reinforcing basis for their safety argument. The key distinction is that in manned aviation, the biggest Risk is to the people on board. They are continually exposed to the Risk, which means these metrics for determining failure rates for equipment (failure per flight hour) are appropriate for manned Aircraft."

Then, it uses the average population density.

9.10. FAA Critical Area

No information on this section is available at this time.

9.11. EASA Critical Area

For the critical area calculations made in Annex F, the formulas used are those in the JARUS model, presented on page 79 (Chapter B.3) of the document currently under consultation. The model was developed by merging two already existing models to calculate the critical area (RTI and NAWCAD), so some of the factors shown in the JARUS model chapter are further detailed in the paragraphs just above where these two models are detailed. The calculations made in Annex F using the JARUS model use conservative assumptions. However, the JARUS model may be used by applicants to calculate the specific critical area of an operator's sUAS using the assumption (height, speed, characteristic dimension, etc.) that are peculiar to their sUAS and operation, so this could be an option for the formulas to be used.

One parameter to be used as an input is the impact angle, which the applicant can calculate, or, as an alternative, the assumptions made in Annex F Chapter A.2.2 might be used.

The calculation and eventual iGRC reduction should be done directly in Step#2 before applying the mitigations. The applicant can demonstrate that the iGRC table is too conservative for its sUAS; the correction can be made directly in the iGRC table.

9.12. FAA Shelter Factor

No information on this section is available at this time.

9.13. EASA Shelter Factor

Refer to appendix 4.2.2 - Support for sheltering claims can be achieved via several mapping products that supplement the original population data statistics, such as satellite image data. As a general rule, sheltering can be expected to deliver a minus 1 to the GRC by reducing the number of people exposed to 1=10 of the original population value. Further reductions may be possible but would require sufficiently strong evidence supporting the claim that approximately 99 percent of the local population is adequately sheltered

9.14. Reductions

EASA and FAA use mitigations differently.

9.15. FAA Available reduction

Table 12 has a baseline configuration without mitigations, such as a parachute, to reduce the Aircraft's speed and show that it does not harm humans. Thus, we should be able to take credit for reducing the likelihood of a fatality. The FAA wants to ensure that there's an incentive for applicants to do such. So, this last category, that reduced probability of injury, is meant to describe the fact that not only are they operating in areas where there's only a specific population density beneath them or population density equivalent in this case. But even if there is a failure, mitigating features reduce the likelihood of fatality over what the baseline configuration would expect. And because they are mitigating that Risk and other ways, fewer hours are needed; the reliability doesn't need to be as high because the likelihood of a fatality when one of these comes down is reduced. So, then Table 12 reduces almost half in case an effective mitigation system is used.

9.16. EASA Available reduction

in Appendix F Section 4.2.3 by establishing three criterions

- M1(a) Strategic mitigations for ground risk
- M1(b) visual line of sight
- M2 reduces one or both of these terms A.C. P(fatality/collision; LOC)
    - Technical, for example, a parachute which considers training and maintenance aspects

For both the medium and high levels of robustness, the operator may combine various mitigation means to achieve factor 10 or factor 100 in the fatality rate. For instance, to achieve a factor 10 reduction, factor 5 could be achieved by a parachute that reduces the impact speed enough to justify factor 5. In contrast, the remaining factor 2 could be achieved by arguing that the critical area is a factor 2 smaller when the Aircraft is descending in a parachute (since the reduction in the critical area gives the same fatality rate.

iGRC Reduction Methods	None	Low	Medium	High
M1(A)- Strategic mitigations for ground risk	0	-1	-2	-3
M1(B)- VLOS	0	-1	N/A	N/A
M2 - Effects of ground impact are reduced	0	0	-1	- 2 or -3

10. ANNEX 5 (EASA Light UAS SC vs. FAA D&R Comparison table)

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
	SUBPART A – GENERAL				

1	**Light-UAS.2000 Applicability and Definitions** (a) This Special Condition prescribes objective airworthiness standards for the issuance of the type certificate and changes to this type of certificate, for Unmanned Aircraft (UA): (1) intended to be operated in the Specific category and whose operation is demonstrated to be a medium risk; (2) with MTOMs not exceeding 600 kg; (3) not transporting humans; and (4) operated with intervention of the remote pilot or autonomous. (b) For the purposes of this Special Condition, the following definition applies: (1) 'normal flight envelope' means the flight envelope associated with routine operations and/or prescribed conditions; (2) 'operational flight envelope' means the flight envelope associated with warning onset; (3) 'limit flight envelope' means the flight envelope that is set by the unmanned aircraft design limits; (4) 'continued safe flight and landing' means, that the UA is capable of continued controlled flight and landing, possibly using emergency procedures, if applicable, without requiring exceptional remote pilot skill. Upon landing, UA damage may occur as a result of a failure condition; (5) ´ancillary equipment´ means the equipment required for the safe operation of the UA that is not installed in the UA or the Command Unit and that is not part of the specified C2 Link and that is identified and specified in the type design of the UAS *Note:* *Additional SC may have to be prescribed in accordance with point 21.B.75, e.g. in those cases in which the product includes specific technology novelties or design and operation are unconventional, such as UA operated autonomously, lighter-than-air UA or UA operated at very high altitude*	N/A	**CPDR2.1 Applicability** a. The UAS has a command and control (C2) link that enables the pilot-in-command to take contingency action. b. The unmanned aircraft (UA) has a kinetic energy of ≤25,000 ft-lbs. [...] c. The UA is operated ≤ 400ft AGL. d. No operations over open-air assemblies (operations over people are acceptable). e. No flight into known icing. f. Maximum of 20:1 aircraft to pilot ratio. g. The UA must be electrically powered (no turbines, fuel cells, etc.). **D&R.005 Definitions** For purposes of these airworthiness criteria, the following definitions apply. (a) Loss of Control: Loss of control means an unintended departure of an aircraft from controlled flight. It includes control reversal or an undue loss of longitudinal, lateral, and directional stability and control. It also includes an upset or entry into an unscheduled or uncommanded attitude with high potential for uncontrolled impact with terrain. A loss of control means a spin, loss of control authority, loss of aerodynamic stability, divergent flight characteristics, or similar occurrence, which could generally lead to crash. (b) Loss of Flight: Loss of flight means a UA's inability to complete its flight as planned, up to and through its originally planned landing. It includes scenarios where the UA experiences controlled flight into terrain, obstacles, or any other collision, or a loss of altitude that is severe or non-reversible. Loss of flight also includes deploying a parachute or ballistic recovery system that leads to an unplanned landing outside the operator's designated recovery zone.	**2**	As far as FAA establishes listed in D&R Applicability aspects as medium risk ConOPS the paragraphs are parallel. But EASA describes medium risk as more common, which can include more ConOps-es than D&R. See Table 1 It is not a requirement, but the comparison should be made based on a ConOps for both Authorities.

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
2	**Light-UAS 2005 Definition of the operational scenario** The applicant needs to define the limitations associated with the operational scenario within which a safe flight and landing will be demonstrated. *Note: Every application should include a characterization of the operational volume and ground buffers in terms of both ground and air risk, the identified SAIL, and any applicable restriction, limitation, assumption about adjacent areas, and design-related mitigation means which may influence the applicable specification or the means of compliance. The definitions will be in line with the EASA AMC and GM. "Safe flight and Landing" must be interpreted from the perspective of ground and air risk posed to people*	N/A	**D&R.001 Concept of Operations** The applicant must define and submit to the FAA a concept of operations (CONOPS) proposal describing the unmanned aircraft system (UAS) operation in the national airspace system for which unmanned aircraft (UA) type certification is requested. The CONOPS proposal must include, at a minimum, a description of the following information in sufficient detail to determine the parameters and extent of testing and operating limitations: (a) The intended type of operations; (b) UA specifications; (c) Meteorological conditions; (d) Operators, pilots, and personnel responsibilities; (e) Control station, support equipment, and other associated elements (AE) necessary to meet the airworthiness criteria; (f) Command, control, and communication functions; (g) Operational parameters (such as population density, geographic operating boundaries, airspace classes, launch and recovery area, congestion of proposed operating area, communications with air traffic control, line of sight, and aircraft separation); and (h) Collision avoidance equipment, whether onboard the UA or part of the AE, if requested.	1	Comparable as similar information is requested

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
3	**Light-UAS.2010 Accepted Means of Compliance** (a) An applicant can comply with this Special Condition using an acceptable means of compliance (AMC) issued by EASA, or another means of compliance which may include consensus standards, when specifically accepted by EASA. (b) An applicant requesting EASA to accept a means of compliance must provide the means of compliance to EASA in an acceptable form and manner.	N/A	The coresponding requirement is listed in the CPP-DR-2.1	**2**	FAA has defined MoCs's, e.g. for Software (e.g., DO-178C). EASA MoC based on the Shepherd initiative will be available soon
	SUBPART B - FLIGHT				
4	**Light-UAS.2100 Mass and center of gravity** (a) Limits for mass and centre of gravity that provide for the safe operation of the UA are to be determined. (b) The design must comply with each airworthiness standard of this Subpart at critical combinations of mass and centre of gravity within the unmanned aircraft's range of loading conditions using acceptable tolerances. (c) The condition of the UA at the time of determining its empty mass and centre of gravity must be defined and repeatable.	OSO#4: UAS developed to authority recognised design standards (Low)	D&R300 (b) Tests must include an evaluation of the entire flight envelope across all phases of operation and must address, at a minimum, the following (4) Weight; (5) Center of gravity;	**1**	OK as a parallel and implicitly similar to FAA requirement to be compared, except that EASA considers that FTB cannot cover 2100 (c)

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
5	**Light-UAS.2102 Approved Flight envelope and environmental conditions** (a) The applicant needs to determine the normal, operational and limit flight envelope for each flight configuration used in operations. The flight envelopes determination must account for the most adverse conditions for each flight configuration. (b) In defining these envelopes, environmental conditions for which operations are approved need to be considered. (c) For adverse weather conditions for which the UAS is not approved to operate, appropriate operating limitations must prevent inadvertent operation within those adverse conditions or the UAS must have means to detect and avoid or safely exit those conditions. *Note: The flight envelopes might be combined or adapted to the accepted MOC at project level. The MOC will specify the envelopes as applicable for the design and operation of the UA to ensure protection of limitations with appropriate margins such as structural design loads or controllability limits such as a minimum safe speed for each flight configuration and phases of flight;*	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.130 Adverse Weather Conditions** (a) For purposes of this section, "adverse weather conditions" means rain, snow, and icing. (b) Except as provided in paragraph (c) of this section, the UA must have design characteristics that will allow the UA to operate within the adverse weather conditions specified in the CONOPS without loss of flight or loss of control. (c) For adverse weather conditions for which the UA is not approved to operate, the applicant must develop operating limitations to prohibit flight into known adverse weather conditions and either: (1) Develop operating limitations to prevent inadvertent flight into adverse weather conditions; or (2) Provide a means to detect any adverse weather conditions for which the UA is not certificated to operate and show the UA's ability to avoid or exit those conditions. **D&R.320 Verification of Limits** The performance, maneuverability, stability, and control of the UA within the flight envelope described in the UA Flight Manual must be demonstrated at a minimum of 5% over maximum gross weight with no loss of control or loss of flight. D&R.320 Verification of Limits. The performance, maneuverability, stability, and control of the UA within the flight envelope described in the UA Flight Manual must be	1	D&R.320 is similar to 2102(a); .130(b), (c)(1) are similar to .2102(b); .130(c)(2) similar to .2102(c)

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
			demonstrated at a minimum of 5% over maximum gross weight with no loss of control or loss of flight.		
	SUBPART C -STRUCTURES				

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
6	**Light-UAS.2235 Structural strength and deformation** (a) The structure must be shown not to fail throughout the limit flight envelope with sufficient margin to ensure the applicable safety objectives are met. (b) The structure must be shown not to interfere with safe operation throughout the limit flight envelope. (c) The effects of the operating environment must be taken into account when complying with sub paragraphs (a) and (b).	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.320 Verification of Limits** The performance, maneuverability, stability, and control of the UA within the flight envelope described in the UA Flight Manual must be demonstrated at a minimum of 5% over maximum gross weight with no loss of control or loss of flight.	3	. The FAA proposes that the strucrural strength is demontstrated by the flight test with 5% overweigth. This is not accepted by EASA.
7	**Light-UAS.2240 Structural durability (covered by FTB)** Effective inspections or other procedures that are designed to prevent structural failures due to foreseeable causes of strength degradation during the operational life of the UA must be developed. Inspections and procedures must be specified in the Instructions for Continued Airworthiness (ICA) as prepared in accordance with Light-UAS.2625.	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.315 Fatigue** The structure of the UA must be shown to withstand the repeated loads expected during its service life without failure. A life limit for the airframe must be established, demonstrated by test, and included in the ICA.	3	Refer to CPP-DR-2.1 Both requirements are dealing with fatigue. The FAA and EASA are similar in this regards. CPP-D&R-2.1 accepts the concept of a leet lead aircraft. Further information is needed from EASA on this point.

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			CPP-DR-1.1	Class	Comments
8	**Light-UAS.2250 Design and construction principles (a) covered by FTB** (a) The design of each part or assembly must be suitable for the expected operating conditions of the UA. (b) Design data must adequately define the part or assembly configuration, its design features, and any materials and processes used. (c) The suitability of each design detail and part having an important bearing on safety in operations must be determined.	OSO#4: UAS developed to authority recognised design standards (Low)	**CPP D&R 2-1 Design Criteria Table Type Design Data, test reports, needs to show…**	2	CPP-DR-2-1 DESIGN CRITERIA CHECKLIST TABLE is only limited comparable to 2250 Note: Jarus AW is not comparing criteria with a requirement; it just trying to establish the safety intent. A criterion does not require a showing of compliance and is not a requirement imposed by law. There is no equivalent in the requirements proposed by the DNR.
	SUBPART D –DESIGN AND CONSTRUCTION				
9	**Light-UAS.2325 Fire protection** The UA must be designed to minimize the risk of fire initiation and propagation such that ground hazards for people and infrastructure are properly mitigated.	OSO#4: UAS developed to authority recognised design standards (Low)		**3 or 4 (TBD)**	In general, the FAA requirements are for electrical propulsion only. For the Scan Eagle project with a combustion engine the usual fire protection requirement were proposed. [Docket No. FAA–2022–0533] Airworthiness Criteria: Special Class Airworthiness Criteria for the Insitu Inc. ScanEagle3 Unmanned Aircraft EASA is not limited to electrical propulsion

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			CPP-DR-1.1	Class	Comments
10	**Light-UAS.2335 Lightning protection** (a) If the intended operation does not exclude exposure to lightning, the UAS must be protected against the catastrophic effects of lightning. (b) If the intended operation excludes exposure to lightning, limitations must be developed to prohibit flight, including take-off and landing, into conditions where the exposure to lightning is likely.	OSO#24: UAS is designed and qualified for adverse environmental conditions (Low)	**D&R.125 Lightning** (a) Except as provided in paragraph (b) of this section, the UA must have design characteristics that will protect the UA from loss of flight or loss of control due to lightning. (b) If the UA has not been shown to protect against lightning, the UA Flight Manual must include an operating limitation to prohibit flight into weather conditions conducive to lightning activity.	**3**	EASA does not require compliance demonstration for lightning as long no fatalities reasonably can be expectedv (non catastrophic effects). The loss of the UA in this cases is accepted. The FAA requires compliance demonstration for lightning for the loss of the UA (loss of control) independent of fatalities and loss of flight, which couid be according to EASA catastrophic or non catastrophic depending on fatalities. Both accepting operational limitations
11	**Light-UAS.2340 Design and construction information** The applicant needs to define the following design and construction information: (a) operating limitations, procedures and instructions necessary for the safe operation of the UA; (b) instrument markings and placards; (c) any additional information necessary for the safe operation of the UA; and (d) inspections or maintenance instructions to assure continued safe operation.	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.135 Flight Essential Parts.** (a) A flight essential part is a part, the failure of which could result in a loss of flight or unrecoverable loss of UA control. (b) If the type design includes flight essential parts, the applicant must establish a flight essential parts list. The applicant must develop and define mandatory maintenance instructions or life limits, or a combination of both, to prevent failures of flight essential parts. Each of these mandatory actions must be included in the Airworthiness Limitations Section of the ICA.	**2**	Provided the EASA definition of "safe operation" is comparable with the "loss of control", 2340 c & d are similar to D&R.135 b. NOTE: EASA does not use the term Flight Essential Parts per D&R.135a, they refer always to safety operation. NOTE2: None of the searched documents incl. BR and CS-Definition has a definition for "safe operation".

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			CPP-DR-1.1	Class	Comments
12	**Light-UAS.2350 Forced landing or a crash** Where the emergency procedure contains a forced landing or a crash: (a) the UA must be designed with sufficient self-containment features to minimise possible debris, fire or explosions extending beyond the forced landing or crash area; and (b) the Flight Manual for the crew must contain the characteristics of the forced landing or crash area.	OSO#5: UAS is designed considering system safety and reliability (Low)	**D&R.120 Contingency Planning.** (a) The UA must be designed so that, in the event of a loss of the command and control (C2) link, the UA will automatically and immediately execute a safe predetermined flight, loiter, landing, or termination.	3	There is no direct equivalent to the EASA self-containmernt requirement in case of a forced/crash landing. The FAA requests a "safe termination", which could or could not contain a self.containments requirement. EASA requests the self-containment for all forced/crash landing, independent of the reason. The FAA requires the safe termination option only in a C2 link problem.
13	**Light-UAS.2370 Transportation, assembly, reconfiguration and storage** Where a UAS or part of the System is designed to be transportable, assembled and disassembled or reconfigured for transportation or storage: (a) the conditions defined for the transportation and storage must not adversely affect the airworthiness of the UAS; (b) incorrect assembly must be prevented by proper design provisions; and (c) instructions for transportation, disassembling/assembling or reconfiguration and storage and the respective handling must be provided.	OSO#4: UAS developed to authority recognised design standards **(Low)**	**D&R 300 Durability and Reliability.** (c) Tests must include the most adverse combinations of the conditions and configurations in paragraph (b) of this section. (g) Any UAS used for testing must be subject to the same worst-case ground handling, shipping, and transportation loads as those allowed in service.	3	Compliance demonstration at the EASA is based on declaration. Supporting evidence may or may not be available. Compliance demonstration at the FAA requires testing.

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			CPP-DR-1.1	**Class**	**Comments**
14	**Light-UAS.2375 Payload Accommodation (a)1 covered by FTB** (a) The provisions for installation or accommodation of payload internal or external to the UA and for loading and releasing of payload must be designed to: (1) minimize hazards to the UA or to third parties during normal operation, and (2) in case of dangerous goods, not result in high risk for third parties in case of an accident. (b) The applicant needs to provide limitations, procedures and instructions as required for the safe operation with payload.	OSO#5: UAS is designed considering system safety and reliability (Low)	**D&R 300 Durability and Reliability.** (j) If cargo operations or external-load operations are requested, tests must show, throughout the flight envelope and with the cargo or external-load at the most critical combinations of weight and center of gravity, that— (1) The UA is safely controllable and maneuverable; and (2) The cargo or external-load are retainable and transportable.	**2**	OK as a parallel and implicitly similar FAA requirement to be compared, except that FAA covers it under testing whilst EASA considers that 2375(a)(2) cannot be covered by FTB

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			CPP-DR-1.1	Class	Comments
15	**Light-UAS.2380 Ancillary Equipment not permanently installed on the UA (c) covered by FTB** Where the UA is intended to be used in combination with ancillary equipment not permanently installed on the UA that is required for the safe operation of the UA: (a) the type design of the UA shall specify the performance and, when required, the design of the ancillary equipment; (b) all necessary instructions, information and limitations for the safe and correct interface between the UA and such ancillary equipment needs to be provided in the Flight Manual or a Ground Handling Manual as appropriate; and (c) the UA must be designed to operate safely using the ancillary equipment under the anticipated operating conditions.	OSO#4: UAS developed to authority recognised design standards (Low) OSO#13: External services supporting UAS operations are adequate to the operation (Medium)	**D&R 300(h)**Any UA used for testing must use AE that meet, but do not exceed, the minimum specifications identified under D&R.105. If multiple AE are identified, the applicant must demonstrate each configuration.	2	EASA excludes explicitly the CU (RPS) in this requirement. FAA explicitly includes the RPS as a AE in this requirement FAA compliance demonstration under DNR EASA requires compliance demonstration outside FTB and requires monitoring of external services, when there are provided
	SUBPART E – LIFT/THRUST/POWER SYSTEM INSTALLATION				

16	**Light-UAS.2400 Lift/Thrust/Power systems installation (a) (b) (d) covered by FTB** The Lift/Thrust/Power system installation includes each part of the UA that is necessary for lift/thrust/power generation and affects the control or the safety of the Lift/Thrust/Power systems. (a) Each component of the Lift/Thrust/Power system installation must be designed, arranged, and installed in accordance with applicable airworthiness standards of Subparts C, D and F. (b) Compliance needs to be substantiated via test, validated analysis, or a combination thereof or through evidence of certification of systems or components to acceptable specifications. (c) The hazards in the event of a malfunction or failure of the Lift/Thrust/Power Control Systems and the Lift/Thrust/Power System Installation need to be assessed and mitigated in accordance with the airworthiness standards Light-UAS.2500 and Light-UAS.2510. (d) The Lift/Thrust/Power system installation must take into account anticipated operating conditions and environmental conditions, for which the UA is certified, in addition to foreign object threats. (e) The Lift/Thrust/Power system installation must take into account for (1) anticipated operating and environmental conditions, including foreign object threats;	OSO#4: UAS developed to authority recognised design standards (Low) OSO#5: UAS is designed considering system safety and reliability (Low)	**D&R.305 Probable Failures.** The UA must be designed such that a probable failure will not result in a loss of containment or control of the UA. This must be demonstrated by test. **(a) Probable failures related to the following equipment, at a minimum, must be addressed:** **(1) Propulsion systems;** (2) C2 link; (b) Any UA used for testing must be operated in accordance with the UA Flight Manual. (c) Each test must occur at the critical phase and mode of flight, and at the highest aircraft-to-pilot ratio. **D&R.100 UA Signal Monitoring and Transmission.** The UA must be designed to monitor and transmit to the AE all information required for continued safe flight and operation. This information includes, at a minimum, the following: (b) Status of all critical parameters for all propulsion systems;	**2**	OK as a parallel and implicitly similar FAA requirement to be compared, except that FAA covers it under testing whilst EASA considers that 2400 (c), (e) and (f) cannot be shown to be compliant by FTB and the FTB is only applicable for a), b), d)

	(2) sufficient clearance of moving parts to other unmanned aircraft parts and their surroundings; and (3) likely hazards in operation, including hazards to ground personnel. (f) All necessary instructions, information and limitations for the safe and correct interface between the lift/thrust/power system and the UA need to be available.				

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			CPP-DR-1.1	Class	Comments
	SUBPART F – SYSTEMS AND EQUIPMENT				

17	**Light-UAS.2500 Systems and equipment function - General (b) covered by FTB** (a) Light-UAS.2500, 2505 and 2510 are general airworthiness specifications applicable to systems and equipment installed in the UAS and should not be used to supersede any other specific Light-UAS airworthiness specifications. (b) Equipment and systems required to comply with type certification requirements, airspace requirements or operating rules, or whose improper functioning would lead to a hazard, must be designed and installed so that they perform their intended function throughout the operating and environmental limits for which the UA is certified. Note: Improper functioning of equipment and systems may be caused by intentional unauthorised electronic interaction (IUEI). The applicant should also consider cybersecurity threats as possible sources of 'improper functioning' of equipment and systems. In showing compliance with Light-UAS.2500(b) for equipment and systems whose improper functioning could lead to an unacceptable threat, the guidance of AMC 20-42 may be considered. This AMC provides acceptable means, guidance and methods to perform security risk assessment and mitigation for UAS information systems.	(a) N/A Note: OSO#5 - under updated Annex E: UAS is designed considering system safety and reliability (Low)	**D&R.310 Capabilities and Functions** (a) All of the following required UAS capabilities and functions must be demonstrated by test: (1) Capability to regain command and control of the UA after the C2 link has been lost. (2) Capability of the electrical system to power all UA systems and payloads. (3) Ability for the pilot to safely discontinue the flight. (4) Ability for the pilot to dynamically re-route the UA. (5) Ability to safely abort a takeoff. (6) Ability to safely abort a landing and initiate a go-around. (b)The following UAS capabilities and functions, if requested for approval, must be demonstrated by test: (1) Continued flight after degradation of the propulsion system. (2) Geo-fencing that contains the UA within a designated area, in all operating conditions. (3) Positive transfer of the UA between control stations that ensures only one control station can control the UA at a time. (4) Capability to release an external cargo load to prevent loss of control of the UA. (5) Capability to detect and avoid other aircraft and obstacles. (c) The UA must be designed to safeguard against inadvertent discontinuation of the flight and inadvertent release of cargo or external load. **D&R.115 Cybersecurity** (a) UA equipment, systems, and networks, addressed separately and in relation to other systems, must be protected from intentional unauthorized electronic interactions that may result in an adverse effect on the security or airworthiness of the UA. Protection must be ensured by showing that the security risks	**3 for the 2510** **1 for cybersecurity**	For the "2510" requirement, EASA asks for a systematic analysis, where FAA accepts the compliance demonstration by testing and definition of likely failures without a systematic analysis. Cybersecurity requirements are similar, however EASA requests a security risk assessement, while FAA requirement does not seem to formally require it.

			have been identified, assessed, and mitigated as necessary. (b) When required by paragraph (a) of this section, procedures and instructions to ensure security protections are maintained must be included in the ICA. **D&R.001 Concept of Operations** The applicant must define and submit to the FAA a concept of operations (CONOPS) proposal describing the unmanned aircraft system (UAS) operation in the national airspace system for which unmanned aircraft (UA) type certification is requested. The CONOPS proposal must include, at a minimum, a description of the following information in sufficient detail to determine the parameters and extent of testing and operating limitations: (a) The intended type of operations; (b) UA specifications; (c) Meteorological conditions; (d) Operators, pilots, and personnel responsibilities;		

			(e) Control station, support equipment, and other associated elements (AE) necessary to meet the airworthiness criteria; (f) Command, control, and communication functions; (g) Operational parameters (such as population density, geographic operating boundaries, airspace classes, launch and recovery area, congestion of proposed operating area, communications with air traffic control, line of sight, and aircraft separation); and (h) Collision avoidance equipment, whether onboard the UA or part of the AE, if requested.		

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			CPP-DR-1.1	Class	Comments
18	**Light-UAS.2505 General Requirement on Equipment Installation** Each item of installed equipment must be installed according to limitations specified for that equipment	N/A		**3**	See above for the 2505 requirement The FAA treats the UAS as a black box, lacking individual analysis. Thus, specific item-level limitations remain undefined.

19	**Light-UAS.2510 Equipment, Systems and Installation (partially e.g. not DAL)** (a) The equipment and systems identified in CS-Light UAS.2500, considered separately and in relation to other systems, must be designed and installed such that: (1) hazards are minimized in the event of a probable failure; (2) it can be reasonably expected that a catastrophic failure condition will not result from any single failure; and (3) if the SAIL is IV, a means for detection, alerting and management of any failure or combination thereof, which would lead to a hazard, is available. (b) Any hazard which may be caused by the operation of equipment and systems not covered by LightUAS.2500 must be minimized.	OSO#5: UAS is designed considering system safety and reliability (Low) OSO#10 Safe recovery from technical issue (Medium) OSO#12 The UAS is designed to manage the deterioration of external systems supporting UAS operation (Medium) OSO#19 Safe recovery from Human Error (criterion #3) (Low)	**D&R.110 Software** To minimize the existence of software errors, the applicant must: (a) Verify by test all software that may impact the safe operation of the UA; (b) Utilize a configuration management system that tracks, controls, and preserves changes made to software throughout the entire life cycle; and (c) Implement a problem reporting system that captures and records defects and modifications to the software. **D&R.305 Probable Failures** The UA must be designed such that a probable failure will not result in a loss of containment or control of the UA. This must be demonstrated by test. (a) Probable failures related to the following equipment, at a minimum, must be addressed: (1) Propulsion systems; (2) C2 link; (3) Global Positioning System (GPS);(4) Flight control components with a single point of failure; (5) Control station; and (6) Any other AE identified by the applicant. (b) Any UA used for testing must be operated in accordance with the UA Flight Manual. (c) Each test must occur at the critical phase and mode of flight, and at the highest aircraft-to-pilot ratio. **D&R.300 Durability and Reliability (see under item 7)**	3	The FAA requires addressing flight control components with a single failure point. On the other hand, EASA emphasizes "reasonably" preventing catastrophic failure resulting from any single failure. The FAA focuses on managing FCS single points of failure, while EASA emphasizes broader safety assurances. . EASA: Focuses on equipment, systems, and installation. Aims to minimize hazards in case of probable failures and prevent catastrophic failure from single failures. Requires means for detecting, alerting, and managing failures that could lead to hazards if the Safety Assessment Integrity Level (SAIL) is IV. Requires minimizing hazards caused by non-covered equipment and systems. FAA: Emphasizes software safety, configuration management, and problem reporting. Mandates software verification through testing to ensure safe UA operation. Requires a configuration management system to track software changes. Calls for a problem reporting system to capture software defects and modifications. Focuses on designing UAs to prevent loss of containment or control in case of probable failures. Specifies probable failure concerns related to propulsion systems, C2 link, GPS, flight

					control components, control station, and other applicant-identified AE. Requires UA testing in accordance with the UA Flight Manual, at critical phases and modes of flight. In summary, EASA's requirements focus on equipment and systems design to minimize hazards and prevent catastrophic failures, while FAA's requirements center on software safety and probable failure prevention through testing and management systems. Both agencies aim to ensure safe UAS operation but approach it from slightly different angles.

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			CPP-DR-1.1	Class	Comments
20	**Light-UAS.2511 Containment (FTB only if note 15)** (a) No probable failure of the UAS or of any external system supporting the operation must lead to operation outside the operational volume. (b) When the risk associated with the adjacent areas on ground or adjacent airspace is significantly higher than the risk associated with the operational volume including the ground buffer: (1) the probability of leaving the operational volume must be demonstrated to be acceptable with respect to the risk posed by a loss of containment; (2) no single failure of the UAS or of any external system supporting the operation must lead to its operation outside the ground risk buffer; and (3) software and airborne electronic hardware whose development error(s) could directly lead to operations outside the ground risk buffer must be developed to a standard or methodology accepted by the Agency. *Note 15 FTB: Only where the SAIL demonstration is considered sufficient to cater for (un)containment risk. In coherence with EASA MoC to 2511 it can be considered that the probability of breaching in adjacent areas / volumes is less than 10-SAIL-1 / FH..*	Step#9	**See D&R 305 (under item 19) D&R.300 Durability and Reliability.** The UA must be designed to be durable and reliable when operated under the limitations prescribed for its operating environment, as documented in its CONOPS and included as operating limitations on the type certificate data sheet and in the UA Flight Manual. The durability and reliability must be demonstrated by flight test in accordance with the requirements of this section and completed with no failures that result in a loss of flight, **loss of control, loss of containment,** or emergency landing outside the operator's recovery area. **D&R.305 Probable Failures** The UA must be designed such that a probable failure will not resul**t in a loss of containment** or control of the UA. This must be demonstrated by test. (a) Probable failures related to the following equipment, at a minimum, must be addressed: (1) Propulsion systems; (2) C2 link; (3) Global Positioning System (GPS);(4) Flight control components with a single point of failure; (5) Control station; and (6) Any other AE identified by the applicant. (b) Any UA used for testing must be operated in accordance with the UA Flight Manual. (c) Each test must occur at the critical phase and mode of flight, and at the highest aircraft-to-pilot ratio.	3	OK as a parallel and implicitly similar FAA requirement to be compared, except that FAA covers it under testing while EASA considers that 2511 can be covered by FTB only as per Note 15. Otherwise a systematic analysis is required. However, the test required by the FAA requires the applicant to do an analysis upfront. EASA emphasizes UAS containment within operational limits, managing adjacent risks, and establishing software/hardware standards, including addressing single point failures. FAA prioritizes durability, reliability, and flight tests, with a focus on preventing probable failures through critical component identification.

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			CPP-DR-1.1	Class	Comments
21	**Light-UAS.2512 Mitigation Means linked with Design (see also MoC)** Design features intended to be used as mitigation means must be demonstrated with the adequate level of performance *Note: For mitigation means linked to ground risk the performance demonstration will be covered by the TC (e.g. the integration of a parachute or a frangible design). For tactical mitigation means linked with air risk, as per CIR 947/2019 the performance justifying the mitigation may have to be agreed upon with a different Authority when an operational authorization is applied for (e.g. the use of ADS-B for air risk mitigation must be discussed and agreed with the competent Authority.*	M1/M2	**CPP-DR-2.1** Applicants may get credit (reduction in prescribed test hours) if the UA presents a 30% or lower chance of causing an AIS level 3 or greater injury. One FAA-accepted means but not the only means, to meet this threshold is incorporation of a parachute system that (1) meets ASTM F3322-18 Standard Specification for Small Unmanned Aircraft System (sUAS) Parachutes from the F38 Committee, and (2) reduces the aircraft's pre-impact kinetic energy below 128 foot pounds.	**3**	EASA covers the design of all mitigation means, wheras the FAA covers only a parachute. Related to the parachute, both agencies refering to the ASTM standard F33-18. Refer also the EASA MoC to CS Light-UAS.2512 recently published Note: CPP-DR-2.1 is guidance material, Jarus AW used as a based to establish safety intent.

22	**Light-UAS.2515 Electrical and electronic system lightning protection** For a UAS where exposure to lightning is likely, each electrical or electronic system that performs a function, the failure of which would prevent the continued safe flight and landing or emergency recovery of the UA, must be designed and installed such that: (a) the function at the UAS level is not adversely affected during or after the time when the UAS is exposed to lightning; and (b) the system recovers normal operation of that function in a timely manner after the UAS is exposed to lightning unless the system's recovery conflicts with other operational or functional requirements of the system. *Note: Lightning protection applies to the UA, the CU and the C2 link*	OSO#24: UAS is designed and qualified for adverse environmental conditions (Low)	**D&R.125 Lightning** (a) Except as provided in paragraph (b) of this section, the UA must have design characteristics that will protect the UA from loss of flight or loss of control due to lightning. (b) If the UA has not been shown to protect against lightning, the UA Flight Manual must include an operating limitation to prohibit flight into weather conditions conducive to lightning activity. **D&R.105 UAS AE Required for Safe UA Operations**. (a) The applicant must identify and submit to the FAA all AE and interface conditions of the UAS that affect the airworthiness of the UA or are otherwise necessary for the UA to meet these airworthiness criteria. As part of this requirement— (1) The applicant may identify either specific AE or minimum specifications for the AE. (i) If minimum specifications are identified, they must include the critical requirements of the AE, including performance, compatibility, function, reliability, interface, pilot alerting, and environmental requirements. (ii) Critical requirements are those that if not met would impact the ability to operate the UA safely and efficiently. (2) The applicant may use an interface control drawing, a requirements document, or other reference, titled so that it is clearly designated as AE interfaces to the UA. [...] **D&R.120 Contingency Planning.** (a) The UA must be designed so that, in the	**1**	Both requirements are comparable.

			event of a loss of the command and control (C2) link, the UA will automatically and immediately execute a safe predetermined flight, loiter, landing, or termination. (b) The applicant must establish the predetermined action in the event of a loss of the C2 link and include it in the UA Flight Manual. (c) The UA Flight Manual must include the minimum performance requirements for the C2 data link defining when the C2 link is degraded to a level where remote [...]		

23	**Light-UAS.2510 Equipment, Systems and Installation** (a) The equipment and systems identified in CS-Light UAS.2500, considered separately and in relation to other systems, must be designed and installed such that: (1) hazards are minimized in the event of a probable failure; (2) it can be reasonably expected that a catastrophic failure condition will not result from any single failure; and (3) if the SAIL is IV, a means for detection, alerting and management of any failure or combination thereof, which would lead to a hazard, is available. (b) Any hazard which may be caused by the operation of equipment and systems not covered by Light-UAS.2500 must be minimized. **Light-UAS.2240 Structural durability** Effective inspections or other procedures that are designed to prevent structural failures due to foreseeable causes of strength degradation during the operational life of the UA must be developed. Inspections and procedures must be specified in the Instructions for Continued Airworthiness (ICA) as prepared in accordance with Light-UAS.2625. **Light-UAS.2410 Lift/Thrust/Power Endurance and durability** Each Lift/Thrust/Power System must be subject to	OSO#24: UAS is designed and qualified for adverse environmental conditions (Low)	**D&R.300 Durability and Reliability.** The UA must be designed to be durable and reliable when operated under the limitations prescribed for its operating environment, as documented in its CONOPS and included as operating limitations on the type certificate data sheet and in the UA Flight Manual. The durability and reliability must be demonstrated by flight test in accordance with the requirements of this section and completed with no failures that result in a loss of flight, loss of control, loss of containment, or emergency landing outside the operator's recovery area. (e) Tests must be conducted in conditions consistent with the expected environmental conditions identified in the CONOPS, including electromagnetic interference **(EMI) and high intensity radiated fields (HIRF).**	**3** **2** **2**	For the "2510" requirement, EASA asks for a systematic analysis, where FAA accepts with D&R.300 the compliance demonstration by testing. For structure, both agencies accepting FTB/D&R. For Lift/Thrust/Power both agencies accepting FTB/D&R

	(a) an endurance demonstration of sufficient duration with respect to cycles and power settings in accordance with Light-UAS.2415; (b) a durability demonstration to show that each part of the system has been designed and constructed to minimize the probability of failure of the system and sub-systems between overhaul periods, or between replacement intervals of parts; and (c) an operational demonstration to verify the performance of the system throughout its declared operating range and operational limitations.				

Item	EASA LIGHT UAS SC FOR SAIL III (NOT COVERED BY FTB)	Correlated SORA OSO (LOR)	PARALLEL FAA D&R AIRWORTHINESS CRITERIA (EXCEPT TESTING)	COMPARISON	
			CPP-DR-1.1	Class	Comments
24	**Light-UAS.2520 High-Intensity Radiated Fields (HIRF) Protection** For a UAS where the exposure to HIRF is likely each electrical and electronic system that performs a function, the failure of which would prevent the continued safe flight and landing or emergency recovery of the UA, must be designed and installed such that: (a) the function at the UAS level is not adversely affected during or after the time when the UAS is exposed to the HIRF environment; and (b) the system recovers normal operation of that function in a timely manner after the UAS is exposed to the HIRF environment, unless the system's recovery conflicts with other operational or functional requirements of the system.	OSO#24		**4**	No equivalent FAA requirement regarding HIRF protection have been identified.
25	**Light-UAS.2529 UAS Navigation Function** The UAS must ensure that the UA remains within the applicable spatial limitations or if applicable the intended flight path in all flight phases *Note: Spatial limitations are derived in the context of compliance to 2005*	OSO#4: UAS developed to authority recognised design standards (Low)	On this general level no corresponding FAA requirement	**4**	The intent of the EASA Navigation requirement is implicit in the FAA requirements which are however not explicitly stated

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			CPP-DR-1.1	Class	Comments
26	**Light-UAS.2530 UA External lights** When required by operational rules: (a) lights required for conspicuity at night must have the intensities, colors, and other characteristics to allow an observer to distinguish the UA from a manned aircraft; (b) any position lights and anti-collision lights, must have the intensities, flash rates, colors, fields of coverage, position and other characteristics to provide sufficient time for another aircraft to avoid a collision; (c) any position lights, must include a red light on the port side of the UA, and a green light on the starboard side of the UA spaced as far laterally apart as practical and a white light facing aft as far to the rear of the UA as practicable; (d) a strobe light must be installed;	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.310 Capabilities and Functions** (b)The following UAS capabilities and functions, if requested for approval, must be demonstrated by test: (5) Capability to detect and avoid other aircraft and obstacles.	**3 or 4**	No equivalent requirement for EASA based on operational rules

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			CPP-DR-1.1	Class	Comments
27	**Light-UAS.2575 Command, Control and Communication Contingency (a) covered by FTB** (a) Where the safe operation of the UA requires command, control and communication functionality, the UAS must initiate adequate contingency procedures following a command, control or communication function loss or a degraded status which no longer ensures safe operation of the UA by the remote crew. (b) The contingency procedures must be specified in the Flight Manual for the remote crew for each operational situation. *Note: This airworthiness standard is linked with the C2 Link and has been kept under Subpart F as it relates not only with C2 Link but with how equipment and systems will manage the loss of command, control and communication.*	OSO#5: UAS is designed considering system safety and reliability (Low)	**D&R.120 Contingency Planning** (a) The UA must be designed so that, in the event of a loss of the command and control (C2) link, the UA will automatically and immediately execute a safe predetermined flight, loiter, landing, or termination. (b) The applicant must establish the predetermined action in the event of a loss of the C2 link and include it in the UA Flight Manual. (c) The UA Flight Manual must include the minimum performance requirements for the C2 data link defining when the C2 link is degraded to a level where remote active control of the UA is no longer ensured. Takeoff when the C2 link is degraded below the minimum link performance requirements must be prevented by design or prohibited by an operating limitation in the UA Flight Manual.	**1**	Similar requirements. The FAA D&R 120 Covers EASA 2575 (a) as well
	SUBPART G – REMOTE CREW INTERFACE AND OTHER INFORMATION				

28	**Light-UAS.2600 Command Unit Integration** (a) This subpart is applicable to the UA in combination with Command Units to remotely control the UA. (b) The type design of the UA must specify the Command Unit design and identify all equipment and systems of the CU that are essential for the crew to operate the UA. (c) Equipment and systems of the CU must be designed and installed in accordance with subpart F. (d) The type design of the UA needs to specify the design of the CU to the level of detail required to ensure compliance with this special condition and the identified design assurance levels. (e) All necessary instructions, information and requirements for the safe and correct interface between the CU and the UA must be available. (f) The Flight Manual shall address all combinations of Command Unit models accepted to control the UA. (g) Design provisions and procedures for safe transfer of control within and between command units, remote crew handovers, and control link switchovers as foreseen for the operation need to be developed. (h) Design provisions and procedures for safe handling during operation and when applicable for configuration, storage and transportation of the CU need to be defined. (i) Procedures for installation and maintaining the CU in a condition for	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.105 UAS AE Required for Safe UA Operations** (a) The applicant must identify and submit to the FAA all AE and interface conditions of the UAS that affect the airworthiness of the UA or are otherwise necessary for the UA to meet these airworthiness criteria. As part of this requirement— (1) The applicant may identify either specific AE or minimum specifications for the AE. i. If minimum specifications are identified, they must include the critical requirements of the AE, including performance, compatibility, function, reliability, interface, pilot alerting, and environmental requirements. ii. Critical requirements are those that if not met would impact the ability to operate the UA safely and efficiently. (2) The applicant may use an interface control drawing, a requirements document, or other reference, titled so that it is clearly designated as AE interfaces to the UA. (b) The applicant must show the FAA the AE or minimum specifications identified in paragraph (a) of this section meet the following: (1) The AE provide the functionality, performance, reliability, and information to assure UA airworthiness in conjunction with the rest of the design; (2) The AE are compatible with the UA capabilities and interfaces; (3) The AE must monitor and transmit to the pilot all information required for safe flight and operation, including but not limited to those identified in D&R.100; and (4) The minimum specifications, if identified,	2	The safety intend is similar. However, the FAA adresses all AE (which includes the CMU), wheras the EASA only adresses the CMU. At EASA the CMU is part of the type design. At FAA the AE are not part of the type design. Therefore, the processes for changes related to the AE/CMU are different

	safe operation need to be made available in the Instructions for Continued Airworthiness (ICA) as prepared in accordance with Light- UAS.2625. (j) The applicant needs to perform satisfactorily integration tests with all approved models of CU as necessary to verify the validity of the declared conditions and limitations and to ensure that the CU will operate satisfactorily and reliably using any C2 Link as specified under the anticipated operating conditions.		are correct, complete, consistent, and verifiable to assure UA airworthiness. (c) The FAA will establish the approved AE or minimum specifications as operating limitations and include them in the UA type certificate data sheet and Flight Manual. (d) The applicant must develop any maintenance instructions necessary to address implications from the AE on the airworthiness of the UA. Those instructions will be included in the instructions for continued airworthiness (ICA) required by D&R.205.		

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			CPP-DR-1.1	Class	Comments
29	**Light-UAS.2602 Command Unit (covered by FTB)** (a) The Command Unit must be adequate to support the command and control of the UA for the intended operations. (b) The CU must provide an adequate work environment and human machine interface to allow for the safe execution of operations. The CU must allow the remote crew to perform their duties without excessive concentration, skill, alertness, or fatigue and its design shall consider human factors principles. (c) The applicant needs to design the system controls and displays so that the remote crew can monitor and perform defined tasks associated with the intended functions of systems and equipment. The system and equipment must be designed to minimise the flight crew errors and must account for flight crew errors which could result in additional hazards.	OSO#20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission (Low)	**D&R.105 UAS AE Required for Safe UA Operations (see under item 27)**	**4**	No comparable requirement have been formally identified in the FAA D&R regarding Command Unit HMI.

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			CPP-DR-1.1	Class	Comments
30	**Light-UAS.2605 Command Unit Installation and operation information - (c) and (d) covered by FTB** (a) The minimum number of crew members or the acceptable UA to crew ratio for safe operation of the CU and UAS must be established. (b) Each item of installed equipment related to the remote crew interface must be labelled, if applicable, as for its identification, function, or operating limitations, or any combination of these factors. (c) There must be a discernible means of providing system operating parameters required to operate the UA including warnings, cautions, and normal indications, to the responsible remote crew. (d) Information concerning an unsafe system operating condition must be provided in a timely manner to the crew member responsible for taking corrective action. The information must be clear enough to avoid likely crew member errors. (e) Information related to safety equipment must be easily identifiable and its method of operation must be clearly marked.	OSO#20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission (Low)	**D&R.100 UA Signal Monitoring and Transmission (is it really parallel???)** The UA must be designed to monitor and transmit to the AE all information required for continued safe flight and operation. This information includes, at a minimum, the following: (a) Status of all critical parameters for all energy storage systems; (b) Status of all critical parameters for all propulsion systems; (c) Flight and navigation information as appropriate, such as airspeed, heading, altitude, and location; and (d) Communication and navigation signal strength and quality, including contingency information or status. **D&R.105 UAS AE Required for Safe UA Operations** (b) The applicant must show the FAA the AE or minimum specifications identified in paragraph (a) of this section meet the following: (3) The AE must **monitor and transmit** to the pilot all information required for safe flight and operation, including but not limited to those identified in D&R.100; and	**3**	Similar intent regarding information to be presented tt the Remote Pilot to ensure safe operation however, quite different wording that makes the comparison more difficult EASA's Light-UAS.2605 focuses on command unit (CU) operation info and labeling. It establishes crew ratios, system parameters, unsafe condition alerts, and safety equipment clarity. FAA's D&R.100 outlines UA monitoring and transmission, encompassing energy and propulsion systems, flight data, and signal strength. D&R.105 mandates AE compliance, ensuring data for safe flight, including D&R.100 parameters. EASA emphasizes crew and system operation while FAA emphasizes comprehensive UA monitoring and data transmission. FAA does not require human factors analysis, whereas EASA seems to require it.

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			CPP-DR-1.1	Class	Comments
31	**Light-UAS.2610 Instrument markings, control markings and placards** (a) The CU must display in a conspicuous manner any placard and instrument marking necessary for operation. (b) The design must clearly indicate the function of each control, unless obvious. (c) The applicant needs to include instrument marking and placard information in the Flight Manual.	OSO#4: UAS developed to authority recognised design standards (Low)	**D&R.105 UAS AE Required for Safe UA Operations** (b) The applicant must show the FAA the AE or minimum specifications identified in paragraph (a) of this section meet the following: (3) The AE must monitor and transmit to the pilot all information required for safe flight and operation, including but not limited to those identified in D&R.100; and	3	Similar intent regarding information to be presented tt the Remote Pilot to ensure safe operation however quite different wording that makes the comparison more difficult
31	**Light-UAS.2615 Flight, navigation, and thrust/lift/power system instruments (a) covered by FTB** Installed systems must provide the remote crew member, who sets or monitors parameters for the flight, navigation, and lift/thrust/power system the information necessary to do so during each phase of flight. This information must: (a) be presented in a manner that the crew members can monitor the parameters and trends, as needed to operate the UA; and (b) include limitations, unless the limitation cannot be exceeded in all intended operations.	OSO#20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission (Low)	**D&R.100 UA Signal Monitoring and Transmission (see under above item 29)** The UA must be designed to monitor and transmit to the AE all information required for continued safe flight and operation. This information includes, at a minimum, the following: (a) Status of all critical parameters for all energy storage systems; (b) Status of all critical parameters for all propulsion systems; (c) Flight and navigation information as appropriate, such as airspeed, heading, altitude, and location; and (d) Communication and navigation signal strength and quality, including contingency information or status.	2	The requirements have similar safety intentions, but the wording is different. In addition, the FAA D&R is more specific than the EASA SC.

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			CPP-DR-1.1	Class	Comments
32	**Light-UAS.2620 Flight Manual** The applicant needs to provide a Flight Manual containing the following information: (a) operating limitations and procedures, for the intended operation; (b) performance information; (c) loading information; (d) procedures and limitations for transportation, reconfiguration and storage; (e) instrument marking and placard information; and (f) any other information necessary for the safe operation of the UAS.	OSO#8, 14, 21: Operational procedures are defined, validated and adhered to (High) *Not in EASA matrix?*	**D&R.200 Flight Manual** The applicant must provide a Flight Manual with each UA. (a) The UA Flight Manual must contain the following information: (1) UA operating limitations; (2) UA operating procedures; (3) Performance information; (4) Loading information; and (5) Other information that is necessary for safe operation because of design, operating, or handling characteristics. (b) Those portions of the UA Flight Manual containing the information specified in paragraph (a)(1) of this section must be approved by the FAA.	1	Equivalent requirement, only different wording
32	**Light-UAS.2625 Instructions for Continued Airworthiness (ICA)** (a) The applicant needs to prepare Instructions for Continued Airworthiness that are appropriate for the UAS design and intended operation. (b) The Instructions for Continued Airworthiness must contain a Section titled 'Airworthiness limitations' that is segregated and clearly distinguishable from the rest of the document. This Section must contain a legible statement in a prominent location that reads: 'The Airworthiness limitations Section is approved and variations must also be approved'.	OSO#7 Inspection of the UAS (product inspection) to ensure consistency to the ConOps (Medium) *Not in EASA matrix?*	**D&R.205 Instructions for Continued Airworthiness** The applicant must prepare ICA for the UA in accordance with Appendix A to Part 23, as appropriate, that are acceptable to the FAA. The ICA may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first UA or issuance of a standard airworthiness certificate, whichever occurs later. **D&R.105 UAS AE Required for Safe UA Operations (d)** D&R.105 UAS AE Required for Safe UA Operations (d) The applicant must develop any maintenance instructions necessary to address implications from the AE on the	2	Similar requirements. FAA has a direct reference to Appendix A of Part 23, whereas the EASA is less prescriptive. Both addressing the entire system.

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			CPP-DR-1.1	Class	Comments
			airworthiness of the UA. Those instructions will be included in the instructions for continued airworthiness (ICA) required by D&R.205.		
	SUBPART H – C2 LINK				

33	**Light-UAS.2710 General Requirements** (a) This subpart is applicable for C2 Link command, control and communication function required for the safe operation of the UA. (b) C2 link performances must be specified as part of the Type Design of the UA (c) C2 Link Performance needs to be provided in the Flight Manual.	OSO#6: C3 link performance is appropriate for the operation (Low)	**D&R.105 UAS AE Required for Safe UA Operations (a), (b), (c)** (a) The applicant must identify and submit to the FAA all AE and interface conditions of the UAS that affect the airworthiness of the UA or are otherwise necessary for the UA to meet these airworthiness criteria. As part of this requirement— (1) The applicant may identify either specific AE or minimum specifications for the AE. i. If minimum specifications are identified, they must include the critical requirements of the AE, including performance, compatibility, function, reliability, interface, pilot alerting, and environmental requirements. ii. Critical requirements are those that if not met would impact the ability to operate the UA safely and efficiently. (2) The applicant may use an interface control drawing, a requirements document, or other reference, titled so that it is clearly designated as AE interfaces to the UA. (b) The applicant must show the FAA the AE or minimum specifications identified in paragraph (a) of this section meet the following: (1) The AE provide the functionality, performance, reliability, and information to assure UA airworthiness in conjunction with the rest of the design; (2) The AE are compatible with the UA capabilities and interfaces; (3) The AE must monitor and transmit to the pilot all information required for safe flight and operation, including but not limited to those identified in D&R.100; and (4) The minimum specifications, if identified,	**2**	The safety intend is similar. However, the FAA adresses all AE (which includes the C2-Link), whereas the EASA only adresses the C2-Link. At EASA the CMU is part of the type design. At FAA the AE are not part of the type design.

			are correct, complete, consistent, and verifiable to assure UA airworthiness. (c) The FAA will establish the approved AE or minimum specifications as operating limitations and include them in the UA type certificate data sheet and Flight Manual.		

34	**Light-UAS.2715 C2 Link Performances (covered by FTB)** (a) The C2 link performance must be adequate to ensure safe operation and must be protected from external interference. (b) The C2 Link system message sequencing must be such to preserve the safety of the operation. *Note: Usage of frequency spectrum is not approved as part of the Type Certificate As per EASA AMC and GM and EASA SC-RPAS.C2-01 the main parameters that can be utilized to qualify the performance of a C2 link (RLP) and of other communication links (e.g. RCP for communication with ATC) include, but are not limited to, effective range, latency, availability, continuity,*	OSO#6: C3 link performance is appropriate for the operation (Low)	D&R.105 UAS AE Required for Safe UA Operations (a) The applicant must identify and submit to the FAA all AE and interface conditions of the UAS that affect the airworthiness of the UA or are otherwise necessary for the UA to meet these airworthiness criteria. As part of this requirement— (1) The applicant may identify either specific AE or minimum specifications for the AE. i. If minimum specifications are identified, they must include the critical requirements of the AE, including performance, compatibility, function, reliability, interface, pilot alerting, and environmental requirements. ii. Critical requirements are those that if not met would impact the ability to operate the UA safely and efficiently. (2) The applicant may use an interface control drawing, a requirements document, or other reference, titled so that it is clearly designated as AE interfaces to the UA. (b) The applicant must show the FAA the AE or minimum specifications identified in paragraph (a) of this section meet the following: (1) The AE provide the functionality, performance, reliability, and information to assure UA airworthiness in conjunction with the rest of the design; (2) The AE are compatible with the UA capabilities and interfaces; (3) The AE must monitor and transmit to the pilot all information required for safe flight and operation, including but not limited to those identified in D&R.100; and (4) The minimum specifications, if identified,	**2**	Refer to 42

			are correct, complete, consistent, and verifiable to assure UA airworthiness. (c) The FAA will establish the approved AE or minimum specifications as operating limitations and include them in the UA type certificate data sheet and Flight Manual. (d) The applicant must develop any maintenance instructions necessary to address implications from the AE on the airworthiness of the UA. Those instructions will be included in the instructions for continued airworthiness (ICA) required by D&R.205.		

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			CPP-DR-1.1	Class	Comments
35	**Light-UAS.2720 C2 Link Performance monitoring (covered by FTB)** If required for safe operation: (a) the UAS remote crew must have the means to continuously monitor C2 link performance and ensure that it continues to meet the identified required operational performance; and (b) appropriate technical and procedural means must be provided to the remote crew to establish and maintain the C2 link, including, where applicable, the interaction with the Command & Control Communication Service (C2CSP). The Applicant needs to provide these means within the Flight Manual.	OSO#6: C3 link performance is appropriate for the operation (Low)	**D&R.100 UA Signal Monitoring and Transmission** The UA must be designed to monitor and transmit to the AE all information required for continued safe flight and operation. This information includes, at a minimum, the following: (a) Status of all critical parameters for all energy storage systems; (b) Status of all critical parameters for all propulsion systems; (c) Flight and navigation information as appropriate, such as airspeed, heading, altitude, and location; and (d) Communication and navigation signal strength and quality, including contingency information or status. **Plus:** **D&R.105 UAS AE Required for Safe UA Operations**	2	Similar requirements. The EASA is specific adressing the link performance monitoring wheras the FAA is more general and adressing mainly the monitoring of the information transmitted. D&R100 (d) is adressing Communication and navigation signal strength which can be interpreted as C2 link strength

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			CPP-DR-1.1	Class	Comments
36	**Light-UAS.2730 C2 Link Security (see also note to Light-UAS 2500 under item 17)** (a) Information exchange between the Command Unit and the UA via the C2 Link must be secure to prevent unauthorized interference with the UA. (b) The C2 Link system must enable the UA to unambiguously and at any time ensure that it is controlled by an authorized Command Unit. **Related to 2500:** Note: Improper functioning of equipment and systems may be caused by intentional unauthorised electronic interaction (IUEI). The applicant should also consider cybersecurity threats as possible sources of 'improper functioning' of equipment and systems. In showing compliance with Light-UAS.2500(b) for equipment and systems whose improper functioning could lead to an unacceptable threat, the guidance of AMC 20-42 may be considered. This AMC provides acceptable means, guidance and methods to perform security risk assessment and mitigation for UAS information systems.	OSO#6: C3 link performance is appropriate for the operation (Low)	**D&R.115 Cybersecurity** (a) UA equipment, systems, and networks, addressed separately and in relation to other systems, must be protected from intentional unauthorized electronic interactions that may result in an adverse effect on the security or airworthiness of the UA. Protection must be ensured by showing that the security risks have been identified, assessed, and mitigated as necessary. (b) When required by paragraph (a) of this section, procedures and instructions to ensure security protections are maintained must be included in the ICA.	2	Similar design requirements, but EASA is requesting a risk assessment in addition.