

ED-325 Vol.1

GUIDANCE DOCUMENT FOR SPECIAL CONDITION LIGHT-UAS – MEDIUM RISK - VOLUME 1

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FOREWORD

1. This document was developed by EUROCAE Working Group 105 “UAS” Sub-Group 4 “Design and Airworthiness”, and was approved by the Council of EUROCAE on 20 December 2024.
2. Volume 1 presents a proposal of Means of Compliance (MoC) to the EASA Special Condition for Light Unmanned Aircraft Systems - Medium Risk, applicable to a number of selected requirements in Subparts B, C, D, E and H. Additional requirements of Subparts F and G are covered in Volume 2.
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CHAPTER 1

INTRODUCTION

This document presents a proposal of Means of Compliance (MoC) to the EASA Special Condition for Light Unmanned Aircraft Systems - Medium Risk [R8] applicable to a number of selected requirements in Subparts B, C, D, E and H. Additional requirements of Subparts F and G will be covered in Volume 2 to be issued at a later stage.

NOTE: *Medium risk refers to Specific Operations Risk Assessment (SORA) Specific Assurance and Integrity Level (SAIL) III and IV.*

NOTE: *Requirements not covered in this document should be addressed by the applicant with the relevant authority. Considering that, as indicated in this document, some of SORA Operational Safety Objectives may be correlated with these requirements¹, these Means of Compliance may also be used in order to prepare Compliance Evidence Documents included in the SORA Safety portfolio in the framework of the Specific Operational Authorization process.*

For each requirement, the way compliance may be demonstrated is indicated with the Means of Compliance Code – MC1 to MC9 - as adopted by EASA – see Appendix to AMC 21.A.20(b) [R19].

Considering the number of possible UAS configurations and applications, in many instances, this document provides to the applicant several options, without adopting a prescriptive approach, with regard to the way compliance may be demonstrated. The exact Means of Compliance will have to be discussed with the Competent Authority on a case-by-case basis.

This document is the result of the work performed by EUROCAE WG-105 SG-4, which has gathered representatives from UAS industry and Aviation Authorities, including EASA. In addition, the results of SHEPHERD project's assessment [R28] of standards potentially usable to demonstrate compliance with the requirements of SC Light-UAS has been taken into consideration and are referred to when appropriate.

These proposed Means of Compliance have been established with the attempt to be as open and non-prescriptive as possible with regards to design and technology used and to UAS configurations. In particular, due to the wide range of different designs, system architectures and Concepts of Operations (ConOps), detailed guidance on test setups and analyses is not provided in this document. This should be handled on a case-by-case basis by the applicant considering their particular project.

Also, being that the EASA Special Condition covers a wide range of masses (weights) up to 600 kg, it is reminded that the applicant may choose to use the Functional Test Based (FTB) MoC [R9] in SAIL III applications, instead of the traditional MoC proposed in this document. Their partial application or alternative Means of Compliance would have to be negotiated on a case-by-case basis.

Additional clarifications on the scope of the document, including applicability and definitions, are given in Subpart A.

¹ A correlation between Special Condition Light-UAS requirements and Operational Safety Objectives is available at <https://www.easa.europa.eu/en/domains/civil-drones-rpas/specific-category-civil-drones/design-verification-report>.

CHAPTER 2

REFERENCES

2.1 APPLICABLE DOCUMENTS

Ref.	Document Number and Revision	Title
[R1]	ASTM F2908-18	Standard Specification for Unmanned Aircraft Flight Manual (UFM) for an Unmanned Aircraft System (UAS)
[R2]	ASTM F2909-19	Standard Specification for Continued Airworthiness of Lightweight Unmanned Aircraft Systems
[R3]	ASTM F3005-14a	Standard Specification for Batteries for Use in Small Unmanned Aircraft Systems (sUAS)
[R4]	ASTM F3062/F3062M-16	Standard Specification for Installation of Powerplant Systems
[R5]	ASTM F3065/F3065M-21a	Standard Specification for Aircraft Propeller System Installation
[R6]	ASTM F3298-19	Standard Specification for Design, Construction, and Verification of Lightweight Unmanned Aircraft Systems (UAS)
[R7]	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
[R8]	EASA SC Light-UAS Medium Risk 01 Issue 01	Special Condition for Light Unmanned Aircraft Systems – Medium Risk
[R9]	EASA FTB MoC SC Light-UAS Issue 1, May 2022	EASA Functional Test Based Means Of Compliance with SC Light-UAS
[R10]	EUROCAE ED-266	Guidance on Spectrum Access Use and Management for UAS
[R11]	JARUS SORA Annex F	Theoretical Basis for Ground Risk Classification
[R12]	RTCA DO-311A	Minimum Operational Performance Standards for Rechargeable Lithium Batteries and Battery Systems
[R13]	SAE ARINC 852	Guidance for security event logging in an IP environment
[R14]	UL2271	ANSI/CAN/UL/ULC Standard for Batteries for Use In Light Electric Vehicle (LEV) Applications
[R15]	UL2580	Batteries for use in electric vehicles
[R16]	UL3030	Standard for Unmanned Aircraft Systems
[R17]	UN38.3	Certification for Lithium Batteries
[R18]	D2.1-D3.1	SHEPHERD EASA Project: Identification of satisfactory industry standards and justification for not acceptable industry standards
[R19]	Annex I to ED Decision 2012/020/R	Acceptable Means of Compliance and Guidance Material for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations – Issue 2
[R20]	FAA AC 27-1B	FAA Advisory Circular 27-1B, Certification of Normal Category Rotorcraft
[R21]	EUROCAE ED-280	Guidelines for UAS safety analysis for the Specific category (low and medium levels of robustness)
[R22]	IEC 62133	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications
[R23]	N/A	N/A

[R24]	RTCA - DO-377B	Minimum Aviation System Performance Standards for C2 Link Systems Supporting Operations of Uncrewed Aircraft Systems in U.S. Airspace
[R25]	ASD-STAN prEN 4709-001:2024 (E)	Unmanned Aircraft Systems – Part 001: Product requirements and verification
[R26]	EU 2019/947	Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (Text with EEA relevance.)
[R27]	MOC Light-UAS.2510-01 01/02/2024	Means of Compliance with Light-UAS.2510 Equipment, Systems and Installation
[R28]	EASA Critical Area Assessment Tool (CAAT)	https://www.easa.europa.eu/en/domains/drones-air-mobility/operating-drone/critical-area-assessment-tool-caat

2.2

ACRONYMS

AGL	Above Ground Level
AMC	Acceptable Means of Compliance
ARA	Airspace Risk Assessment
ARC	Air Risk Class
ATC	Air Traffic Control
BRLOS	Beyond Radio Line of Sight
CNPC	Control and Non-Payload Communications
ConOps	Concept of Operation
CMU	Control and Monitoring Unit
C2	Control and Command
DAA	Detect and Avoid
DdoS	Distributed Denial of Service
DoS	Denial of Service
EASA	European Union Aviation Safety Agency
EMC	Electromagnetic Compatibility
EME	Electromagnetic Environment
ETSO	European Technical Standard Order
FCS	Flight Control System
FTB	Functional Test Based
GNSS	Global Navigation Satellite System
HIRF	High-Intensity Radiated Field
ICD	Interface Control Document
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
LUAS	Light Unmanned Aircraft System
MC or MoC	Means of Compliance
MEM	Minimum Empty Mass
MEW	Minimum Empty Weight
MTOM	Maximum Takeoff Mass
MTOW	Maximum Takeoff Weight
OSO	Operational Safety Objective
PKI	Public Key Infrastructure
RLOS	Radio Line of Sight
RPAS	Remotely Piloted Aircraft System
SAIL	Specific Assurance Integrity Level
SHEPHERD	Standards Evaluation Project supporting European Regulations for Drones

SC	Special Condition
SORA	Specific Operational Risk Assessment
TLS	Transport Layer security
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UFM	Unmanned Aircraft Flight Manual
UMM	Unmanned Aircraft Maintenance Manual
UL	Underwriters Laboratories
UN	United Nations
VLA	Very Light Aeroplanes

2.3 MEANS OF COMPLIANCE

MC# (e.g. MC1) is used in the document to refer to particular means of compliance. From [R19]:

Type of Compliance	Means of Compliance	Associated Compliance Documents
Engineering evaluation	MC0: - Compliance statement - Reference to Type Design documents - Election of methods, factors, etc. - Definitions	Type Design documents Recorded statements
	MC1: Design review	Descriptions Drawings
	MC2: Calculation/analysis	Substantiation reports
	MC3: Safety assessment	Safety analysis
Tests	MC4: Laboratory tests	Test programmes Test reports Test interpretations
	MC5: Ground tests on related product	
	MC6: Flight tests	
	MC8: Simulation	
Inspection	MC7: Design inspection/audit	Inspection or audit reports
Equipment qualification	MC9: Equipment qualification	Note: Equipment qualification is a process which may include all previous means of compliance.

NOTE: The representativity of analysis (“MC2”) or tests (“MC4”, “MC5” and “MC9”) should be considered for each demonstration.

The model used for analysis should be validated. The validation of the model should be done by comparing results of the analysis to results of a test campaign covering the boundaries of relevant parameters. It should be noted that the content of the validation depends on the purpose of the analysis.

Alternatively, when available/applicable, the applicant may use models for which a wide acceptance within the industry can be shown (e.g. International Standard Atmosphere).

Examples are:

- For functional/integration validation of FCS within the whole UAS, the used model should be representative of UAS equipment in terms of internal logic/state machine/interface control document (ICD).
- For performance assessment, the used model should be representative of the UA flight dynamics.

NOTE: *If flight tests (“MC6”) is used, the amount of flight tests to be performed may be established in accordance with ASTM F3478-20 [R7].*

NOTE: *Extrapolation or Interpolation of flight tests (“MC6”) might be used if it is suitable for the intended purpose (e.g. extrapolation for altitude effects as in AC 27-1B [R20]).*

2.4

DEFINITIONS

In the context of MoCs for SAIL III and IV:

- ‘Applicant’ is the designer of the UAS.
- ‘Likely failure’ is meant to be ‘probable failure’ and probable failure is the one anticipated to occur one or more times during the operational life of the UAS’.
- ‘Flight envelope’ is the set of boundaries that define the aircraft’s operating limits for altitude, airspeed, load factor, and other parameters. It also defines the operating limits required for a specific flight phase or mission².

For definitions not added in this document, the applicant may use ASTM F3298-19 [R6], section 3.

While MoC, MOC and MC refer to the same terms (Means of Compliance), MoC is generally used for broader means of compliance, MOC to given references and MC to types of means of compliance (as per EASA [R19]).

Due to the different types of UAS operations and human required human interactions with UAS, the term “remote crew” is privileged over pilot or remote pilot to account for such differences, especially in the context of highly automated operations.

The following definitions, most of them taken from ED-266 [R10], are considered in the document to specify the C2 link performance, noting that for medium risk (SAIL III & IV), they can be interpreted in a qualitative way.

- **Operating Range:** the maximum distance within which a control system (such as radio communication) can reliably maintain a link between the UAS and the ground station. This distance is limited by the technology’s inherent transmission capabilities.
- **Coverage:** the extent of the area or network over which a control system (such as satellite or internet-based communication) can maintain a reliable link. Coverage is theoretically unlimited, dependent on infrastructure availability rather than distance.
- **Communication transaction time:** the maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure.
- **Availability:** the probability that an operational communication transaction can be initiated when needed.
- **Continuity:** the probability that a transaction can be completed within the communication transaction time given that the service was available at the start of the transaction (either ET or TT of 95%).
- **Integrity:** the probability of one or more undetected errors in a completed communication transaction.
- **Latency:** the time interval between the start of the transmission of a message and the beginning of its receipt. It has to be considered both ways (from CU to UA and from UA to CU).

² Examples from LSA (EASA): <https://www.easa.europa.eu/download/general-aviation/documents-guidance-and-examples/ABCD-FE-01-00%20Flight%20Envelope%20-%20v1%2008.03.16.docx>

CHAPTER 3

SUBPART A: GENERAL

This subpart does not include requirements, but applicability and definitions. The requirements are added into this document for reference.

3.1

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 certificate, for Unmanned Aircraft (UA):

- (1) Intended to be operated in the Specific category and whose operation is demonstrated to be medium risk;
- (2) With MTOMs not exceeding 600 kg;
- (3) Not transporting humans; and
- (4) Operated with intervention of the remote pilot or autonomous.

NOTE: Medium risk refers to SAIL III and IV.

NOTE: This document is applicable to any configuration respecting Light-UAS.2000. However, applicants considering that their configurations are not properly covered or represented by the document may need to propose alternative strategies to their competent authority.

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.

Establishing prescriptive criteria to define the limit, the operational and the normal flight envelopes is not possible for UAS of different types and sizes. However, the following rules are suggested as general guidelines. Applicants considering that these limits are not properly adapted to their configuration may need to propose alternative definitions. In this case, they should base their justification on the amplitude of the target parameter, target operational conditions, potential variation of the parameter and impact on the operation, etc.

General:

Compared to the limit flight envelope, applicants may define the parameters of the operational flight envelope as no more than 90% of the limits defined in the limit flight envelope (e.g. the maximum operating speed should not be more than 0.9 times the maximum design speed). Similarly, compared to the limit flight envelope, applicants may define the parameters of the normal flight envelope as no more than 80% of the limits defined in the limit flight envelope.

Hereunder are proposed alternative criteria to define safety margins between the limit and operational flight envelope (Safety Margin 1) and the limit and normal flight envelope (Safety Margin 2).

Speeds (ground speeds, airspeeds and wind speeds):

- Safety Margin 1:
 - The safety margin should be the smallest of the following:
 - 10%
 - 5 m/s
 - The resulting speed is then the highest of:
 - Operational speed = Limit speed x 0.9
 - Operational speed = Limit speed - 5 m/s
- Safety Margin 2:
 - The safety margin should be the smallest of the following:
 - 20%
 - 10 m/s
 - The resulting speed is then the highest of:
 - Operational speed = Limit speed x 0.8
 - Operational speed = Limit speed - 10 m/s

NOTE: *for stall speeds or other inferior limits, the relation should be the opposite.*

- Operational speed = Stall speed x 1.1 or Stall speed + 5 m/s
- Limit speed = Stall speed x 1.2 or Stall speed + 10 m/s

Masses/weights (OEW/OEM, MTOW/MTOM, etc.) and load factors:

- Safety Margin 1:
 - The safety margin should be 3%.
 - The resulting mass/weight is:

$$\text{Operational mass or weight} = \text{Limit mass or weight} \times 0.97$$
- Safety Margin 2:
 - The safety margin should be 5%.
 - The resulting mass/weight is:

$$\text{Operational mass or weight} = \text{Limit mass or weight} \times 0.95$$

Temperatures:

- Safety Margin 1:
 - The safety margin should be 5°C.
 - The resulting temperature is then:

$$\text{Operational temperature} = \text{Limit temperature} \pm 5^{\circ}\text{C}$$
- Safety Margin 2:
 - The safety margin should be 10°C.
 - The resulting temperature is then:

$$\text{Normal temperature} = \text{Limit temperature} \pm 10^{\circ}\text{C}$$

NOTE: *for superior limits (e.g. operating high temperature), applicants should use -5°C, while for inferior limits (e.g. operating low temperature), applicants should use +5°C.*

Attitude and angles (pitch, roll, etc.):

- Safety Margin 1:
 - The safety margin should be 5% of the amplitude.
 - The resulting angle is then:

$$\text{Operational angle} = \text{Limit angle} \pm 0.05 \times \text{Amplitude of the angle}$$
- Safety Margin 2:
 - The safety margin should be 10% of the amplitude.

- The resulting angle is then:

$$\text{Operational angle} = \text{Limit angle} \pm 0.1 \times \text{Amplitude of the angle}$$
 - Example: for a given UAS, the limit pitches are -30° and 30° . Therefore:
 - The operational pitches are -27° and 27° .
 - The normal pitches are -24° and 24° .
- NOTE:** *equivalent safety margins may be used for other attitude related parameters.*

Altitudes (ceiling):

- Safety Margin 1:
 - The safety margin should be the smallest of the following:
 - 5%
 - 750 ft or 225 m
 - The resulting altitude is then the highest of:
 - Operational altitude = Limit altitude $\times 0.95$
 - Operational altitude = Limit altitude - 750 ft or 225 m
- Safety Margin 2:
 - The safety margin should be the smallest of the following:
 - 10%
 - 1500 ft or 450 m
 - The resulting altitude is then the highest of:
 - Operational altitude = Limit altitude $\times 0.9$
 - Operational altitude = Limit altitude - 1500 ft or 450 m

NOTE: *inferior altitude limits (e.g. minimum deployment altitude for parachute) should be addressed on a case by case, considering the cause of the limitation (e.g. presence of obstacles, potential deviation due to navigation and/or weather conditions, etc.).*

Precipitations (maximum rain and/or snow):

- Safety Margin 1:
 - The safety margin depends on the limit conditions:
 - 0.5 mm/h below 5 mm/h
 - 1 mm/h between 5 and 10 mm/h
 - The smaller of 10% and 1.5 mm/h above 10 mm/h
- Safety Margin 2:
 - The safety margin depends on the limit conditions:
 - 1 mm/h below 5 mm/h
 - 2 mm/h between 5 and 10 mm/h
 - The smaller of 20% and 3 mm/h above 10 mm/h

Exemptions:

When applicants are not able to identify the limit parameters, they may take the maximum parameter for which safety and control is kept during flight, and select it as the limit parameter. For example, if an applicant is unable to test practically wind conditions above 30 m/s, but can show that at that speed the relevant requirements from this standard are met, the applicant may assume that its wind limit is 30 m/s.

NOTE: *This exemption should allow applicants to force virtual limit parameters that, as a minimum, should provide the same level of safety margins that the (unknown) effective limit parameters. The objective is to not block applicants from demonstrating given requirements when the testing conditions cannot be controlled (e.g. wind speed or other weather conditions) or are restrictive to meeting (e.g. due to the relative cost of the tests).*

CHAPTER 4

SUBPART B: FLIGHT

4.1 LIGHT-UAS.2100 MASS AND CENTER OF GRAVITY

NOTE: *If an FTB program is proposed for demonstration of compliance with SC Light-UAS.2100, the applicant should refer to “Functional Test Based Means of Compliance with SC Light-UAS” published in May 2022 [R9] or latest version. This FTB MoC is applicable to SAIL III and below.*

a) Limits for mass and centre of gravity that provide for the safe operation of the UA are to be determined.

The applicant should determine and specify at least the following masses (weights) of the vehicle:

- Maximum Takeoff Mass MTOM / Maximum Takeoff Weight (MTOW)
- Minimum Empty Mass MEM / Minimum Empty Weight (MEW)

It should also be specified what onboard equipment, including payload and deployable payload, or fluids are included in these masses (weight).

The applicant should determine the longitudinal and lateral Centre of Gravity range to ensure that safe operation can be maintained throughout the operational flight envelope.

The applicant should provide all relevant data in their Unmanned Aircraft Flight Manual and/or Unmanned Aircraft Maintenance Manual (“MC1”) as applicable.

Tolerances provided in ASTM F3298-19 [R6] section 5.1.5 are acceptable for demonstrating compliance with this subpart.

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.

The applicant should determine the most critical combination of mass and Centre of Gravity position for each test required by this subpart. A short rationale analysis (“MC2”) should be provided for each test. Tolerances provided in ASTM F3298-19 [R6] section 5.1.5 are acceptable for demonstrating compliance with this subpart.

c) The condition of the UA at the time of determining its empty mass and centre of gravity must be defined and repeatable.

The applicant should provide a description of the procedure to determine masses (weights) and the Centre of Gravity in their Unmanned Aircraft Flight Manual and/or Unmanned Aircraft Maintenance Manual (“MC1”) as applicable. This procedure should specify the configuration of the aircraft, its equipment and fluids that are part of the minimum empty mass (weight), any jigs and tools required to determine its empty mass (weight) and its centre of gravity, and environmental conditions under which the procedure should be performed as well as data that should be recorded. ASTM F3298-19 [R6] section 16.2.2 proposes a list of items that should be included in the minimum empty mass (weight) of the aircraft. If the UA configuration consists of removeable power sources, i.e., batteries, then the minimum empty mass (weight) should be the mass which corresponds to the minimum mass configuration.

4.2 LIGHT-UAS.2102 APPROVED FLIGHT ENVELOPE AND ENVIRONMENTAL CONDITIONS

NOTE: *If an FTB program is proposed for demonstration of compliance with SC Light-UAS.2102, the applicant should refer to “Functional Test Based Means of Compliance with SC Light-UAS” published in May 2022 [R9] or latest version. This FTB MoC is applicable to SAIL III and below.*

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.

The applicant should establish the normal, operational and limit flight envelope for the most adverse conditions for each flight configuration of the aircraft. The normal, operational and limit flight envelopes should be provided in the relevant Unmanned Aircraft Flight Manual ("MC1") and should contain all data required to safely operate the aircraft. The applicant should provide minimum and maximum speeds and altitudes to safely take off, cruise, manoeuvre, and land the aircraft. If certain phases of flight, e.g., hovering, have time limitations other than autonomy, the maximum duration should also be stated in the relevant manual.

Parameters involved in the definition of the flight envelopes are, as a minimum and as applicable³: relevant masses or weights (at least MTOM) and positions of the centre of gravity, load factors, relevant speeds (minimum and maximum), angles (longitudinal and lateral angles of attack, pitch, roll and yaw), altitude, wind and any other relevant environmental condition.

Further guidance with respect to various speeds can be found in ASTM F3298-19 [R6] section 9.6. In particular, 'maximum design speed' or 'limit speed' may be interpreted as the highest speed at which an UA can safely operate under any condition (the lowest between design diving speed and never exceed speed). As this ASTM standard provides guidance for fixed-wing and rotary wing aircraft, the list may be curtailed or extended as required based on the applicant's configuration. The applicant may deviate from proposed values provided that safe operation can be maintained.

NOTE: *The margins between the normal and operational flight envelopes with the limit flight envelope are defined in the section of LIGHT-UAS.2000 of this document.*

The applicant may demonstrate these envelopes in flight tests ("MC6") which may also be part of or an extension to the FTB programme, if applicable. The applicant may justify the combination of individual flight tests justifying equivalent limits for different flight configurations (e.g. different flight configurations may have the same limits for certain environmental conditions, such as temperature, rain, humidity, etc.).

b) In defining these envelopes, environmental conditions for which operations are approved need to be considered.

The applicant should provide the envelopes determined in SC Light-UAS.2102 (a) considering different environmental conditions such as ranges of temperature, altitude above mean sea level, precipitation, wind, and gusts that potentially affect the performance of the aircraft.

The applicant should also demonstrate these envelopes in adverse environmental conditions in flight tests ("MC6") which may also be part of or an extension to the FTB programme, if applicable some portions could also be performed in an equipment qualification campaign ("MC9"). The applicant may justify the combination of individual flight tests justifying equivalent limits for different flight configurations (e.g. temperature, rain, humidity, icing, High-Intensity Radiated Field (HIRF), etc.).

If the aircraft is approved for flight in certain ranges of e.g., altitude or temperature, the lower and the upper limit of these ranges should be tested unless analysis ("MC2") is used to demonstrate compliance.

If the applicant chooses to demonstrate compliance through analysis ("MC2"), the model used for analysis should be validated, and evidence should be provided upon request by the competent authority. The validation of the model should be done by comparing the results of the analysis to the results of a test campaign covering the boundaries of relevant parameters.

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.

³ Examples can be seen in <https://www.easa.europa.eu/en/downloads/124035/en>

The applicant should provide environmental operating conditions and associated limitations in their Unmanned Aircraft Flight Manual ("MC1").

If the UAS is not equipped with the means to detect such conditions, procedures to avoid them should be described in the manual and performance should be demonstrated as part of the flight tests or FTB programme as applicable ("MC6").

If the UAS is equipped with the means to detect such conditions, procedures should be described in the manual and performance should be demonstrated as part of the flight tests or FTB programme as applicable ("MC6"). The UAS could rely on external services and/or ground sensors.

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; Environmental conditions should include meteorological conditions such as wind, rain and icing as well as external factors that may interfere with the performance of systems such as HIRF.*

4.3

LIGHT-UAS.2105 PERFORMANCE DATA

NOTE: *If an FTB program is proposed for demonstration of compliance with SC Light-UAS.2105, the applicant should refer to "Functional Test Based Means of Compliance with SC Light-UAS" published in May 2022 [R9] or latest version. This FTB MoC is applicable to SAIL III and below.*

a) The performance of the UA must be adequate to ensure the safety of the intended operation in the operational envelope.

The applicant should determine whether the performance defined by the data required by SC Light-UAS.2105(b) is adequate to safely operate the aircraft within the operational flight envelope.

The applicant may demonstrate compliance with this paragraph through flight tests ("MC6") which may also be part of or an extension to the FTB programme, if applicable.

b) Sufficient data on the performance of the UA needs to be determined and provided in the Flight Manual to provide the remote crew with the necessary information and relevant operational parameters to ensure a safe minimum performance for the intended flight operation.

The applicant should determine all relevant performance data to safely operate the aircraft. Relevant performance data to safely operate the aircraft are all data that are needed by the remote crew or used in programming the flight control system and data required to ensure minimum performance. This data should allow the remote crew to keep the operation within or to return the aircraft back inside limits of the approved flight envelope. This might include but is not limited to:

- Minimum and maximum speeds for takeoff, climb, manoeuvre, cruise, hovering, and landing;
- Minimum and maximum climb and descent rates;
- Minimum turning radii;
- Minimum area and length of takeoff and landing areas;
- Minimum distance to fully stop the rotary wing aircraft (i.e. minimum distance to decelerate the UA from applicable and relevant speeds to the minimum steady flight speed at which the aircraft is controllable, including 0 m/s or hovering) or turn it around for fixed-wing;
- Maximum duration for manoeuvres as applicable;
- When applicable, the conditions and/or actions required to trigger given manoeuvres associated to maximum/minimum performance (e.g. loiter, automatic contingency/emergency manoeuvres, etc.).
- Any other data required to safely operate the aircraft: ASTM F2908-18 [R1] section 7.6 and ASTM F3298-19 [R6] section 6 propose lists of performance data that should be considered by the applicant and curtailed or extended as

applicable. The applicant may deviate from proposed values provided that safe operation can be maintained. The determination of minimum performance values different from ASTM F2908-18 [R1] should consider e.g., any request for evasive manoeuvres or any unexpected change of atmospheric condition.

NOTE: *AMC1 Article 11 of (EU) 2019/947 from ED Decision 2020/022/R requires several minimum performance parameters depending on the air risk class. E.g., for beyond visual line of sight operations in ARC-c a minimum climb/descent rate of 500 ft/min and a minimum turn rate of 3°/s. The applicant should make these data available to the operator in the relevant Unmanned Aircraft Flight Manual ("MC1"). It should be indicated if airspeed or ground speed is provided to the remote crew. If the dimension of the UA does not allow the installation of an airspeed sensor, other methods should be developed and provided to inform the remote crew of exceedances of the operational envelope.*

- c) The UA must be able to meet the scheduled performance in still air and standard atmospheric conditions at sea level and up to the ambient atmospheric conditions for the operational flight envelope.**

The applicant should ensure that all performance data required by SC Light-UAS.2105(b) can be met across the operational flight envelope.

The applicant may demonstrate compliance with this paragraph through flight tests ("MC6") which may also be part of the FTB programme if applicable. Flight test data may need to be complemented by an analysis to normalise performance to standard conditions.

- d) The procedures used for determining performance are executable consistently in atmospheric conditions expected to be encountered in operation and by a remote crew of average skill.**

The applicant should develop and document test procedures in the relevant test plans that can be performed across the operational flight envelope and by an averagely skilled flight crew. An averagely skilled flight crew generally consists of individuals who possess a standard level of proficiency and experience necessary to perform their duties safely and effectively.

The applicant may demonstrate compliance with this paragraph through flight tests ("MC6") which may also be part of the FTB programme if applicable.

- e) Losses due to atmospheric conditions, cooling needs, installation, downwash considerations, and other demands on power sources as applicable, as well as system failure conditions in accordance with Light-UAS.2510, must be taken into account.**

The applicant should consider effects of environmental conditions of the operational flight envelope for which approval is sought as well as physical or technical effects which occur during operation when establishing the performance data for the operational flight envelope.

Downwash considerations should take into account, as a minimum, ground effect (in takeoff and landing manoeuvres) and, when applicable, effects of tilting rotors and flight segments near surface and/or close to obstacles.

System failures in accordance with the safety assessment ("MC3") as required by OSO #5 and/or SC Light-UAS.2510 should also be considered and performance degradation due to these should be documented across the operational flight envelope.

The demonstration of compliance with this paragraph should be done through dedicated flight tests ("MC6") which may also be part of or an extension to the FTB programme if applicable.

4.4

LIGHT-UAS.2135 CONTROLLABILITY, MANOEUVRABILITY AND STABILITY

NOTE: *If an FTB program is proposed for demonstration of compliance with SC Light-UAS.2135, the applicant should refer to "Functional Test Based Means of Compliance with SC Light-UAS" published in May 2022 [R9] or latest version. This FTB MoC is applicable to SAIL III and below.*

- a) **The UA must be controllable and maneuverable within the limit flight envelope and must be controllable and maneuverable, without requiring exceptional skill or alertness on the part of the remote crew, within the operational flight envelope:**
- (1) in all loading conditions for which certification is requested;**
 - (2) during all phases of flight including transitions;**
 - (3) with likely flight control or thrust/lift/power system failure; and**
 - (4) during configuration changes.**

The applicant should develop and document operating procedures in the relevant Unmanned Aircraft Flight Manual ("MC1") that can be performed across the operational flight envelope, by a flight crew of average skill level. These procedures should be compatible with the aircraft's performance, and its operational flight envelope, including the mass, the most adverse Centre of Gravity positions and environmental conditions for which approval is sought. All procedures and manoeuvres should be executable across the operational flight envelope with the performance data established as required by SC Light-UAS.2105. Procedures should also cover configuration changes as well as likely failures of flight control or thrust/power system. Additional guidance for controllability and manoeuvrability can be found in ASTM F3298-19 [R6] section 16.1.2. In addition, specific patterns such as 8 shape, donut, and others might be developed to demonstrate acceptable flying qualities. These manoeuvres should encompass typical flight phases and typical missions flight phases, divided accordingly into mission task elements. Examples of possible patterns are provided in Figure 4-1 to Figure 4-3 below; however, the applicant may suggest other patterns based on typical flight manoeuvres made in operations and/or adapt the later to non-uniform line movements (e.g. acceleration/deceleration, climbing/descent, etc.) and applicable environmental conditions (e.g. headwind, sidewind, tailwind, etc.). Performance of these manoeuvres would need to be done either manually or automatically as applicable. In either case an evaluation of remote crew workload compared to a medium skilled remote crew should be made by an external observer. Response of the drone to an exceedance of the operational flight envelope and after likely failures should encompass the initial reaction, and subsequent transition to a safe envelope, up to continued safe flight and landing.

If the applicant demonstrates compliance to this paragraph through laboratory ("MC4") or ground testing ("MC5"), it should be ensured that environmental conditions of the operational flight envelope are tested. This could be done using component tests, system tests, or full-scale tests in e.g., a wind tunnel simulating the most adverse conditions that should be identified for each equipment under test. The applicant should provide a rationale for the parameters chosen based on the operational flight envelope and relevant considerations as to why the chosen setup covers the most adverse conditions for each equipment under test.

If the applicant performs flight tests ("MC6") which might be part of or an extension to the Functional Test Based MoC, the power system performance should be demonstrated through functional test during the whole campaign.