EASA European Union Aviation Safety Agency	**Consultation paper** **Functional Test Based Means of Compliance with SC Light-UAS**	Doc. No. : FTB MOC SC Light-UAS Issue : 1 Date : 14.03.2022 Proposed ☒ Final ☐ Deadline for comments: 04.04.2022

SUBJECT	: Means of Compliance to Special Condition Light UAS for UAS operated in SAIL III and below
REQUIREMENTS incl. Amdt	: Special condition Light-UAS Medium Risk, Initial Issue
ASSOCIATED IM/MoC not applicable]	: Yes☐ / No ☒[Delete last page of associated IM/MoC if
ADVISORY MATERIAL	: N/A

INTRODUCTORY NOTE AND IDENTIFICATION OF ISSUE:

Special Condition (SC) Light UAS 'medium risk' defines objective requirements for UAS operated in the specific category and limited to specific assurance and integrity level (SAIL) III and IV. At the time of release of this document, means of compliance (MoCs) for substantiation of requirements of the SC have not yet been adopted by EASA. With the release of this document for public consultation, EASA proposes to utilize extensive evidence from functional tests, as MoC for a significant subset of specifications of the SC. The approach is considered acceptable for UAS operated in SAIL III and below. This MoC should be considered in relation to this limited spectrum and to this subset of specifications. Furthermore EASA reminds that this MoC is only one means of compliance while other MoC can be proposed for acceptance by the Agency.

BACKGROUND:

The SAIL represents the level of confidence that the UAS operation will remain under control. It is determined by a combination of the final/residual (i.e.: after mitigations have been applied) ground risk class (GRC) and air risk class (ARC), according to the following table[1] :

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			

[1] As per AMC to article 11 of Regulation (EU) 2019/947

The maximum allowable rate of loss of control of the operation per flight hour (FH) is linked with the SAIL[2] and achieved by means of Operational Safety Objectives (OSOs). In the frame of EASA design verification projects (DVP) / Type Certification projects (TC), compliance with SC Light UAS requirements provides evidence of compliance with technical OSOs. Under certain assumptions[3] it is possible to establish a minimum number of successful flight hours for satisfactory compliance demonstration. EASA has identified in this MoC the subset of SC Light UAS requirements whose substantiation by means of this minimum number of successful flight hours is acceptable.

This MoC requires a significant amount of flight test hours to be carried out in controlled and safe conditions with a positive outcome, assessing the envelope of the concept of operation (CONOPS) for the UAS configuration under design verification or certification. The applicant should evaluate whether this is an appropriate methodology for its organisation and the product before opting for this solution.

[2] 10^{-SAIL} / FH

[3] Statistical independence of experiments (no specific demonstration for this element is required as part of this MoC)

Means of Compliance
Functional Test Based (FTB) MoC for SC Light-UAS

1. Applicability

This MoC is applicable to:

- UAS design verification / type certification for operation in the specific category with SAIL III and below, and
- Design verification basis / type certification basis provided by SC Light UAS medium risk SAIL III

2. Methodology

The methodology is composed of the following elements:

1. a demonstration test plan (DTP)
2. demonstration prerequisites
3. data collection criteria
4. final Reporting

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Applicants are invited to refer to ASTM standard F3478-20[4] for elements 1 to 4.

The overall number of flight hours to be distributed across the DTP is expected to be 3000 [5,6]. Test should be performed using a number of aircraft in line with ASTM F3478-20 section 5.3 and agreed with the Agency.

Replacing any subset of the above indicated FHs with ground or laboratory testing needs to be discussed and agreed with the Agency. Applicants should substantiate that at least the same level of confidence on the UAS design as if FHs were performed is achieved.

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[4] F3478-20 Standard Practice for Development of a Durability and Reliability Flight Demonstration Program for Low-Risk Unmanned Aircraft Systems (UAS) under FAA Oversight, published in November 2020.

[5] Specific limitations linked with the CONOPS might be considered for potential adaptation of FHs based on a quantitative approach to ground risk assessment

[6] In case a DVP is voluntarily applied to for SAIL lower than III, EASA would recommend the application of the FTB methodology, which would lead to define a DTP based on a number of FHs not exceeding 300 for SAIL II. SAIL I is not considered a realistic case for a DVP.

Applicants could consider to claim FH operated in a lower SAIL as well as exposure to FH for UAS with similar configuration, provided that flight conditions are proved applicable, that configuration differences are not such to invalidate the tests and that recorded evidence of tests is fully available. Such substantiation elements need to be agreed with the Agency.

The applicant needs to ensure that the data collection and flight test elements are appropriately recorded and representative in order to serve as substantiation for the above mentioned FH.

3. Areas of particular attention

The following aspects linked with the application of the methodology may be particularly challenging and require attention:

- UAS configuration
    - Changes to the configuration after project conclusion may require higher substantiation effort than for projects where non-functional test based MoC have been adopted. Strong configuration control during the project is needed and guidance is provided by ASTM F3478.
- Failures
    - Any failure experienced during the execution of the DTP needs to be recorded and analysed to determine whether it infringes the pass criteria defined in the DTP or any SC Light UAS specifications. In such cases the applicant needs to perform a root cause analysis and define design or procedural modifications to address the failure condition. The root cause analysis and the proposed modifications should be discussed and agreed with the Agency. Modifications, especially when entailing design changes, require additional tests to ensure the validity of the cumulated test hours. The extent of the additional test hours would depend on several factors, including, but not limited to, soundness of the root cause analysis and nature of the modification.
- CONOPS coverage
    - The DTP needs to substantiate the UAS design in the context of the CONOPS associated with the DVR/TC application. This may lead to significant effort for the organization of tests in the appropriate scenario. Guidance is provided by F3478.
- Remote pilot
    - Different capabilities of the remote pilot (considering the role asssigned to them in the UAS operations as a function of the level of automation) may in some cases determine different results in preserving control of the operation. The DTP should be carried out considering that the end user could be operator(s) with remote pilots qualified at the minimum level of what

is prescribed by the EASA AMC to Article 11 of Regulation (EU) 2019/947. Higher qualified pilots for testing corners of the envelope or for carrying out likely failure tests can be necessary, in order to ensure proper assessment of the flight envelope and proper triggering of UAS likely failures

4. Compliance with SC Light UAS

Where the DTP is appropriately defined, this MoC can substantiate the following requirements of SC Light UAS medium risk:

Light-UAS.2100 (a), (b)

Light-UAS.2105

Light-UAS.2135

Light-UAS.2160

Light-UAS.2240

Light-UAS.2250 (a)

Light-UAS.2260

Light-UAS.2300

Light-UAS.2305

Light-UAS.2375 (a1)

Light-UAS.2380 (c)

Light-UAS.2400 (a), (b), (d)

Light-UAS.2405

Light-UAS.2410

Light-UAS.2415

Light-UAS.2430

Light-UAS.2510[7]

[7] Partially covered by the DTP and needing complementing means (e.g. for development assurance aspects)

Light-UAS.2511[8]

Light-UAS.2512[9]

Light-UAS.2528

Light-UAS.2529

Light-UAS.2575 (a)

Light-UAS.2602

Light-UAS.2605 (c), (d)

Light-UAS.2615 (a)

Light-UAS.2715

Light-UAS.2720

Requirements of SC Light UAS not listed above require different means for showing of compliance, such as analysis, inspection of design artefacts, evidence from flight and ground handling manuals, limitations, procedures, maintenance instructions, tests other than flight test and beyond the DTP. Criteria underpinning these means of compliance should be light and pragmatic and should be defined on the base of the first projects opting for a functional test-based (FTB) approach. When mature, EASA may publish the most relevant as further MoC associated with the FTB methodology.

Note: applicants could consider to extend the DTP to substantiate further requirements not above listed provided that they propose adequate complementary means of compliance for those requirements, that the relevant testing is compatible with the functional test campaign and that the Agency agrees with such extension.

5. References

5.1. EU Regulations

— Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (OJ L 152, 11.6.2019, p. 45)

[8] Only where the SAIL demonstration is considered sufficient to cater for (un)containment risk. The demonstration of dedicated containment means such as a flight termination system, or technical mitigation means, could be proposed as integrated in the DTP.

[9] Depending on the feasibility of experimental tests to prove the mitigation means (parachute, frangible design, …)

— Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems (OJ L 152, 11.6.2019, p. 1)

5.2. EASA SC and Guidance Material

— SC for Light UAS
— Guidelines on design verification of UAS operated in the specific category medium risk (SAIL III and IV)

5.3. Standards

— ASTM F3478-20 published on November 2020 “Standard Practice for Development of a Durability and Reliability Flight Demonstration Program for Low-Risk Unmanned Aircraft Systems (UAS) under FAA Oversight”