



Airworthiness

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AGENDA

- Where we are today with UAS airworthiness certification requirements
- Where the regulations are heading
- How you can make sure you're prepared

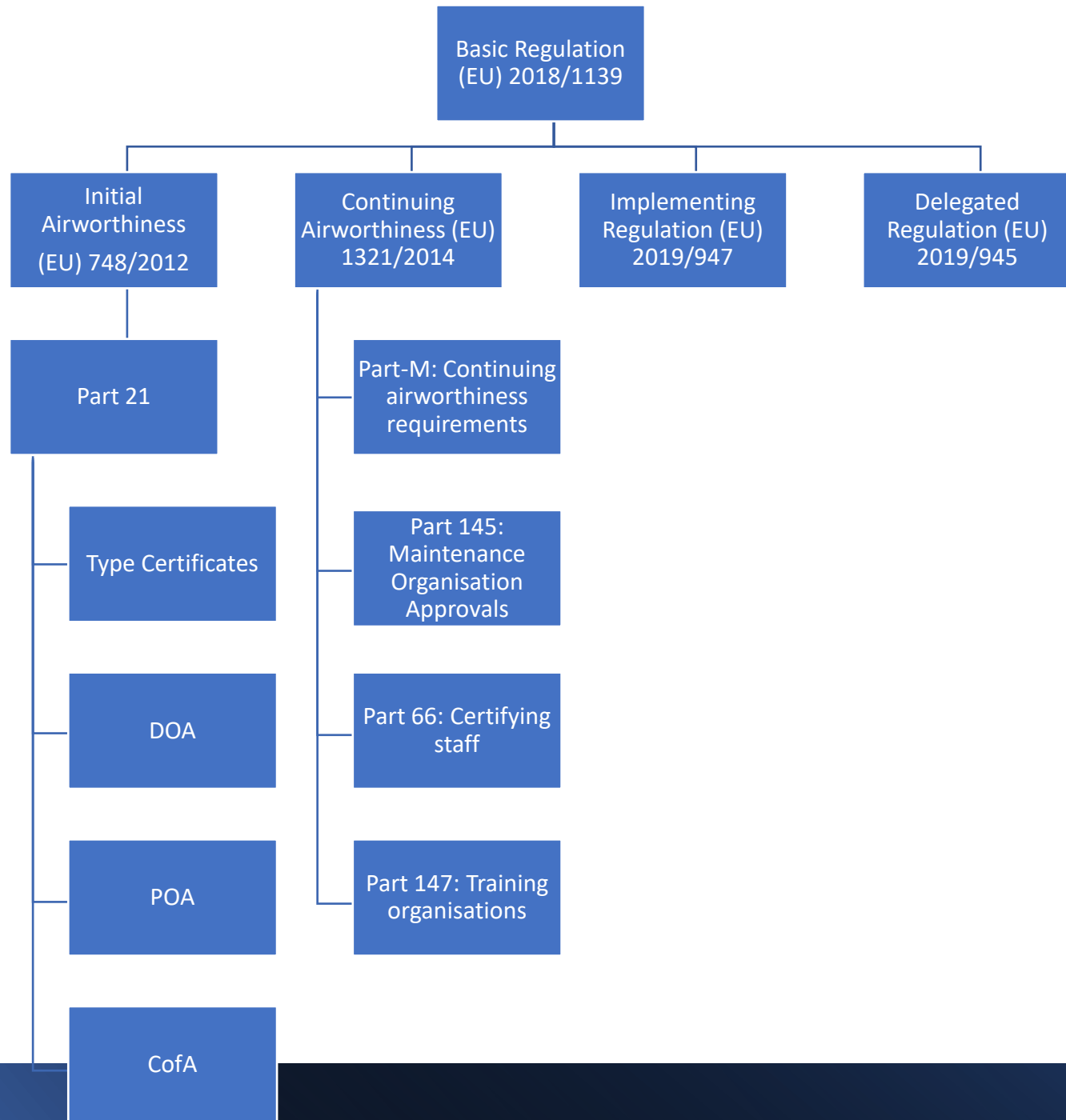




What is Airworthiness?

- Initial
- Continued
- According to....





Requirements for UAS to be 'Certified'

(Delegated Regulation (EU) 2019/945, Article 40)

The design, production and maintenance of UAS shall be certified if the UAS meets any of the following conditions:

- a) it has a characteristic dimension of 3 m or more, and is designed to be operated over assemblies of people;
- b) it is designed for transporting people;
- c) it is designed for the purpose of transporting dangerous goods and requiring a high level of robustness to mitigate the risks for third parties in case of accident;
- d) it is intended to be used in the 'specific' category and the competent authority, following a risk assessment provided for in Article 11 of Implementing Regulation (EU) 2019/947, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS.

Requirements for UAS to be operated in the 'Certified' category

(Implementing Regulation (EU) 2019/947 Article 6 - 'Certified' category of UAS operations)

- The UAS is certified pursuant to Article 40 of Delegated Regulation (EU) 2019/945; and
- The operation is conducted in any of the following conditions:
 - over assemblies of people;
 - involves the transport of people;
 - involves the carriage of dangerous goods, that may result in high risk for third parties in case of accident.

In addition...where the competent authority, based on the risk assessment provided for in Article 11, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS and of the UAS operator and, where applicable, without the licensing of the remote pilot.

Specific operation risk assessment (SORA)

(ED Decision 2020/022/R , AMC1 (& GM1) Article 11 Rules for conducting an operational risk assessment)

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			

Specific assurance and integrity level (SAIL)

(ED Decision 2020/022/R , AMC1 (& GM1) Article 11 Rules for conducting an operational risk assessment)

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			

The maximum allowable rate of loss of control of the operation per flight hour (FH) is linked with the SAIL i.e. $10^{-\text{SAIL}} / \text{FH}$
 By comparison manned aircraft target accident rate is 1×10^{-7} per hour (less than one accident per 10 million hours)

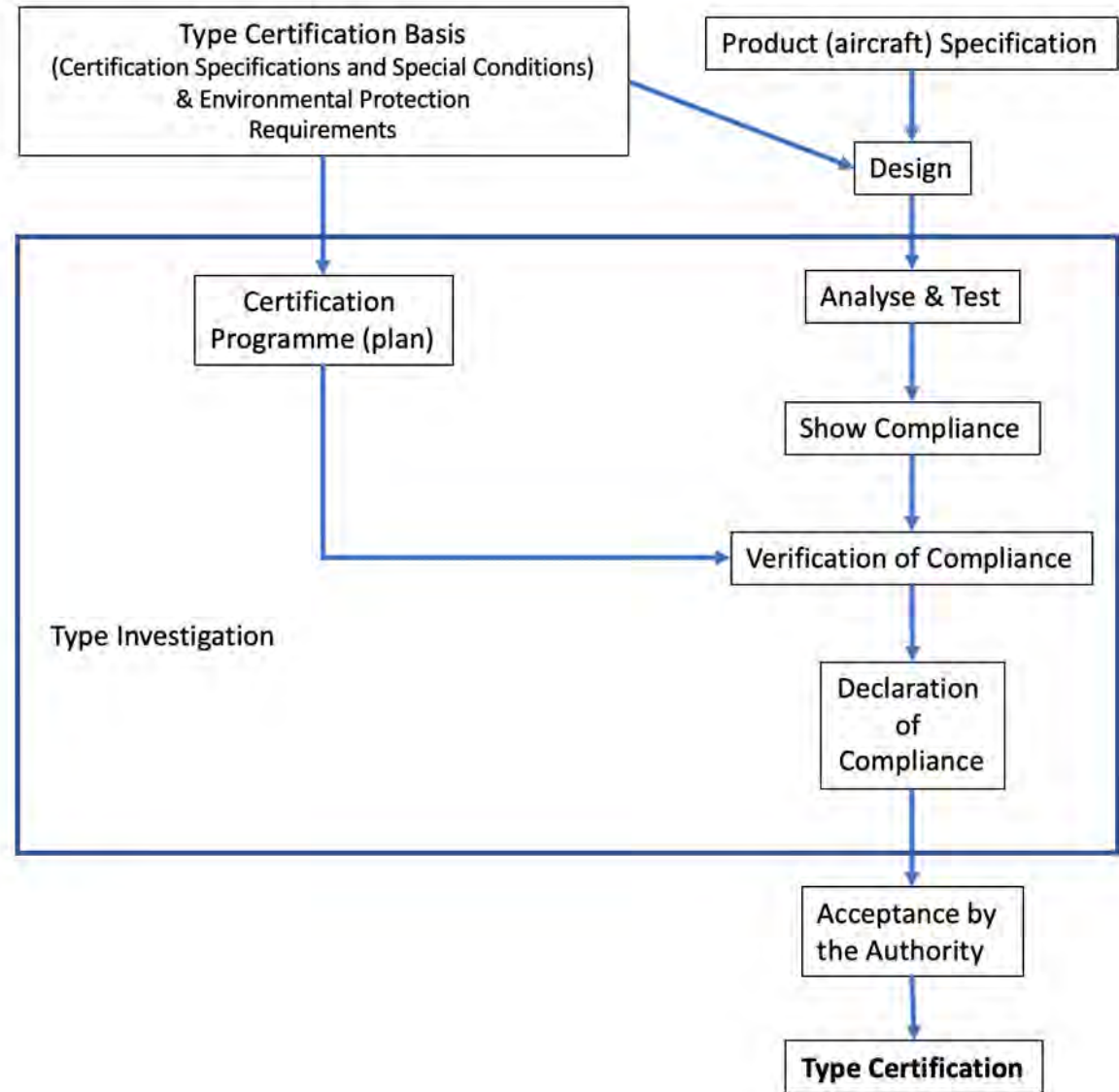
Requirements for Certified UAS

(Delegated Regulation (EU) 2019/945 , Article 40)



- (EU) No 748/2012: rules 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, and
- (EU) No 1321/2014 : the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks (Part M, Part 145 etc)

Type Certification Process



Manned Aircraft Certification Specifications



Design Organisation Approval



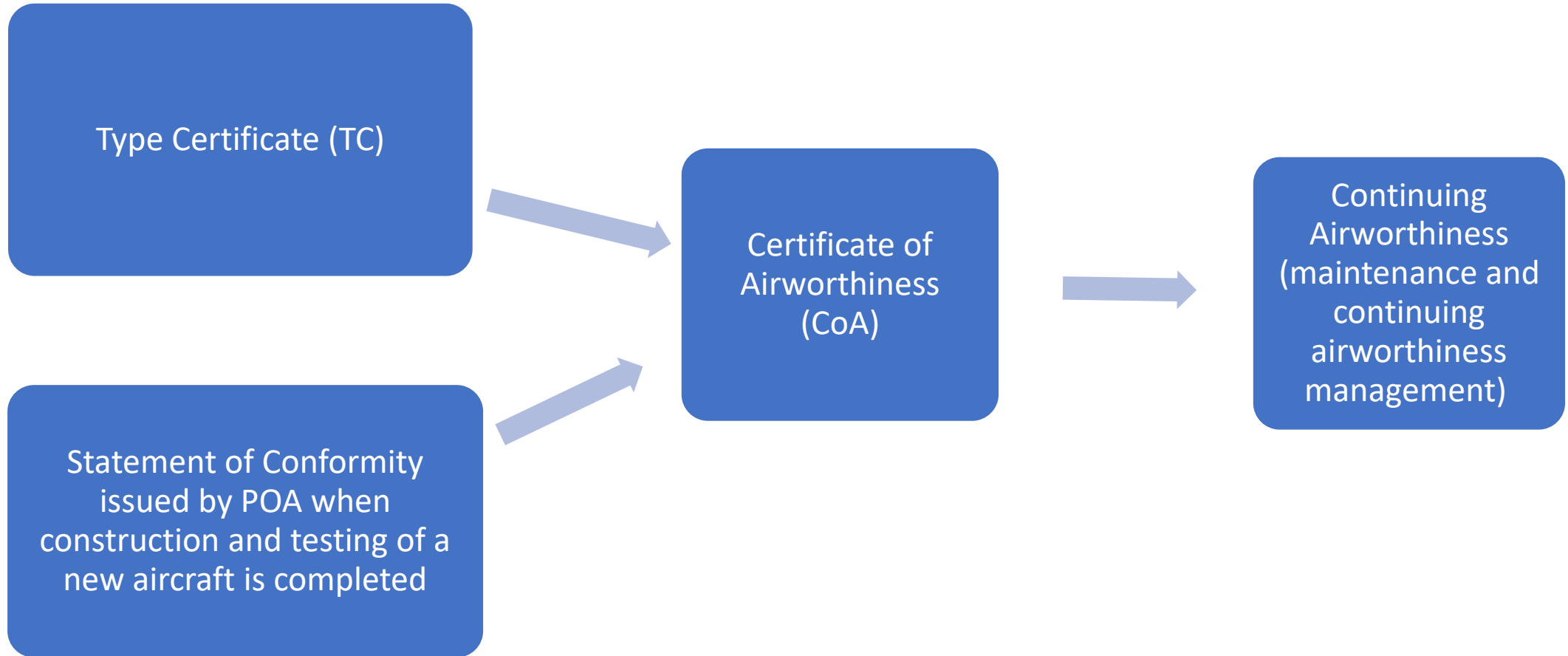
Flight test requirements



- Flight Test Operations Manual (FTOM)
- Conducted under a Permit to Fly issued by the Authority in accordance with Part 21
- The flight time requirements may vary from 150 to 500 hours depending upon the Authority's specific determination and the test plan.

Production Organisation Approval





Continuing Airworthiness

(EU) No 1321/2014)



- Continuing airworthiness means all of the processes ensuring that, at any time in its operating life, the aircraft complies with the airworthiness requirements in force and is in a condition for safe operation.
- Defects and Airworthiness Directives
- Instructions for Continued Airworthiness
- Master Minimum Equipment List (MMEL)
- Maintenance and Repair Organisations (MRO)
- Continued Airworthiness Maintenance Organisation (CAMO)

Proportionality



- Open Category – 'C' markings
- Specific category
 - Low risk – applicant declares compliance
 - Medium risk – design verification by the authority
 - High Risk – Part 21 Type Certification process
- Certified Category – Part 21 Type Certification Process

Special Condition Light Unmanned Aircraft Systems - Medium Risk SC Light-UAS Medium Risk 01, 17 December 2020

- Not intended to transport Humans
- MTOM up to 600 Kg
- Operated in the specific category of operations, medium risk (SAIL III and IV)
- Takes into consideration the design-related OSOs determined by the EASA AMC and GM

EASA Special Condition Light Unmanned Aircraft Systems Cont'd

- High level – Prescribes airworthiness objectives (i.e. does not identify the AMC for the objectives)
- Intended to be applied for future UAS projects for which a TC is applied for
- Addresses airworthiness specifications for UA operated in the specific category
- Various subparts address different design aspects
 - Subpart B - Flight: Mass and Cof G, approved flight envelope etc.
 - Subpart C - Structures: Construction principles, materials etc
 - Etc.
- Also covers aspects like:
 - Flight Manual
 - Instructions for Continued Airworthiness (ICA)




EASA Special Condition VTOL

	<p>SPECIAL CONDITION Vertical Take-Off and Landing (VTOL) Aircraft</p>	<p>Doc. No: SC-VTOL-01 Issue: 1 Date: 2 July 2019</p>
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Special Condition for small-category VTOL aircraft

Statement of Issue


The Agency has received a number of requests for the type certification of vertical take-off and landing (VTOL) aircraft, which differ from conventional rotorcraft or fixed-wing aircraft. In the absence of certification specifications for the type certification of this type of product, a complete set of dedicated technical specifications in the form of a special condition for VTOL aircraft has been developed. This special condition addresses the unique characteristics of these products and prescribes airworthiness standards for the issuance of the type certificate, and changes to this type certificate, for a person-carrying VTOL aircraft in the small category, with lift/thrust units used to generate powered lift and control.

	<p>Means of Compliance with the Special Condition VTOL</p>	<p>Doc. No: MOC SC-VTOL Issue: 2 Date: 12 May 2021</p>
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Means of Compliance with the Special Condition VTOL

	<p>Second Publication of Means of Compliance with the Special Condition VTOL</p>	<p>Doc. No: MOC-2 SC-VTOL Issue: 2 Date: 29 June 2022</p>
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Second Publication of Means of Compliance with the Special Condition VTOL

	<p>Third Publication of Proposed Means of Compliance with the Special Condition VTOL</p>	<p>Doc. No: MOC-3 SC-VTOL Issue: 1 Date: 29 June 2022</p>
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Third Publication of Proposed Means of Compliance with the Special Condition VTOL

Design Verification

(Guidelines on Design
verification of UAS operated
in the 'specific' category and
classified in SAIL III and IV
Issue 1, March 2021)

- Used in the Specific Category
- 'Should' be required by the NAA for any OSOs linked with the design OSOs requiring medium, M2 'effects of ground impact are reduced' claimed as medium, or enhanced containment
- Its scope can cover one or more of the following points:
 - the full design of the UAS;
 - the mitigation means linked with the design;
 - the enhanced containment function.

Design Related OSOs

OSO No.		SAIL					
		I	II	III	IV	V	VI
OSO #02	UAS designed and produced by a competent and/or proven entity	O	O	L	M	H	H
OSO #04	UAS developed to authority recognised design standards	O	O	L	L	M	H
OSO #05	UAS is designed considering system safety and reliability	O	O	L	M	H	H
OSO #06	C3 link performance	O	L	L	M	H	H
OSO #10	Safe recovery from a technical issue	L	L	M	M	H	H
OSO #12	The UAS is designed to manage the deterioration of external systems supporting UAS operations	L	L	M	M	H	H
OSO #13	External services supporting UAS operations are adequate for the operation	L	L	M	H	H	H
OSO #18	Automatic protection of the flight envelope from human error	O	O	L	M	H	H
OSO #19	Safe recovery from human error	O	O	L	M	M	H
OSO #20	A human factors evaluation has been performed and the human machine interface (HMI) found appropriate for the mission	O	L	L	M	M	H
OSO #24	UAS is designed and qualified for adverse environmental conditions	O	O	M	H	H	H

EASA Special Condition Light Unmanned Aircraft Systems - Medium Risk SC Light-UAS Medium Risk 01, 17 December 2020 (adopted)



OSO #04 — UAS developed to authority recognised design standards

TECHNICAL ISSUE WITH THE UAS		Low
OSO #04 UAS developed to authority recognised design standards	Criteria	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a <u>low</u> level of integrity and the intended operation.
	Comments	<i>In case of experimental flights that investigate standards are not met.</i>

TECHNICAL ISSUE WITH THE UAS		Low
OSO #04 UAS developed to authority recognised design standards	Criteria	Consider the criteria defined in Section 9
	Comments	<i>The competent authority may request EASA to validate the claimed integrity.</i>

SC LUAS	Type	OSO	LoR SAIL III	LoR SAIL IV
SUBPART B - FLIGHT				
Light-UAS.2100 Mass and centre of gravity (a) Limits for mass and centre of gravity that provide for the safe operation of the UA are to be determined.	SC	4	L	L
Light-UAS.2100 Mass and centre of gravity (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.	SC	4	L	L
Light-UAS.2100 Mass and centre of gravity (c) The condition of the UA at the time of determining its empty mass and centre of gravity must be defined and repeatable.	SC	4	L	L
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.	SC	4	L	L

- All requirements have a defined relationship with the OSOs shown in a 'Compliance Matrix for Design Verification Purposes'.

Design Verification

(Guidelines on Design verification of UAS operated in the 'specific' category and classified in SAIL III and IV Issue 1, March 2021)

- Need to establish the design verification basis
- Since the SC for Light UAS is objective-based, these means of compliance need to achieve two targets:
 1. specify the concrete UAS design-related auditable or measurable data, and
 2. define how to demonstrate compliance with this data (e.g. design review, calculation/analysis, laboratory tests, ground tests, flight tests etc.)
- May propose means of compliance based on:
 - existing technical specifications or industry standards or their relevant sections, or
 - propose new means of compliance (MoC) if no adequate specifications / standards can be identified.

Means of Compliance with Light-UAS.2511 Containment

(MOC Light-UAS.2511-01, May 2022)



- Addresses SORA step#9 enhanced containment
- For a declaration to the authority for up to SAIL II & up to 3m
- To ensure that an UAS out of control will not breach into adjacent areas with undefined trajectory i.e. Flight Termination Systems
- Flight tests: at least 10 activations
- Flight Manual contains details
- Maintenance instructions established

Functional Test Based Means of Compliance with SC Light-UAS

(FTB MOC SC Light-UAS , May 2022)



For UAS operated in SAIL III and below

- Utilises extensive evidence from functional tests conducted during a Demonstration Test Plan (DTP)
- Voluntary for SAIL II: 300 FH
- Nominal number of flight hours across the DTP for SAIL III: 3,000 FH
- May be able to reduce FH with ground or laboratory testing hours
- UAS configuration 'frozen'

Formulating a proposed MoC



- Need to have a proposed MoC for each requirement or group of relevant requirements of the SC-Light UAS
- Technically appropriate
- Use applicable sections (or modify them) where gaps exist

Other MoCs



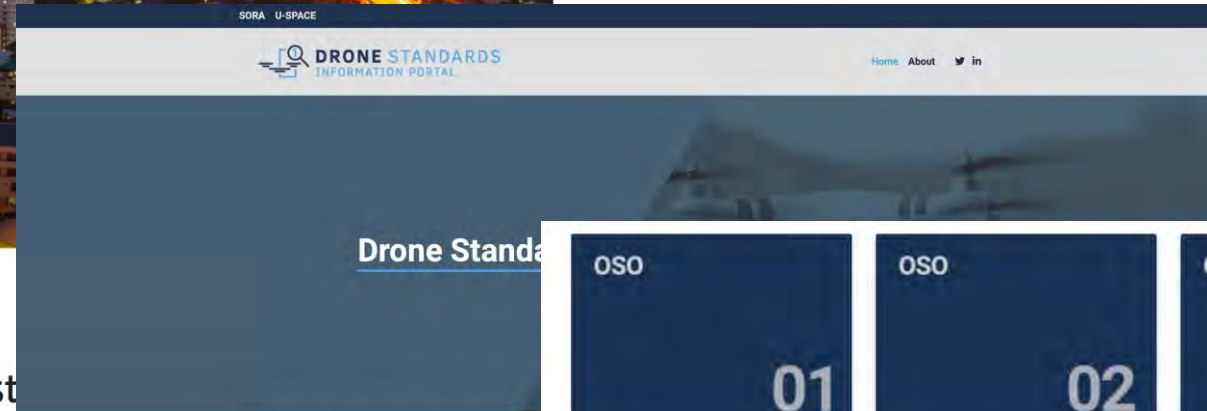
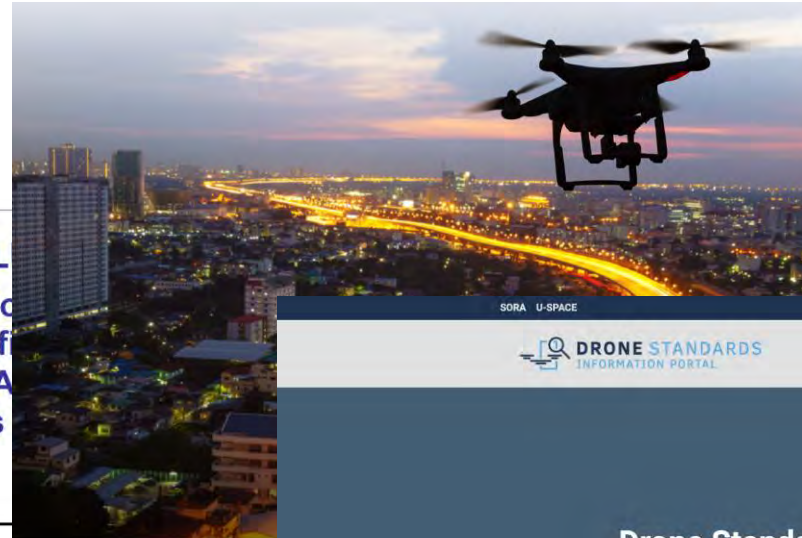
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JARUS CS-L
Recommendation
Certification Specific
Light Unmanned A
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UAS st

The Drones Standards Information Portal is :
 or under development,

ENTER THE

<p>OSO</p> <p>01</p> <p>SORA OSO 01</p> <p>Ensure the operator is competent and/or proven</p>	<p>OSO</p> <p>02</p> <p>SORA OSO 02</p> <p>UAS manufactured by competent and/or proven entity</p>	<p>OSO</p> <p>03</p> <p>SORA OSO 03</p> <p>UAS maintained by competent and/or proven entity</p>
<p>OSO</p> <p>04</p> <p>SORA OSO 04</p> <p>UAS developed to authority recognized design standards</p>	<p>OSO</p> <p>05</p> <p>SORA OSO 05</p> <p>UAS is designed considering systems safety and reliability</p>	<p>OSO</p> <p>06</p> <p>SORA OSO 06</p> <p>C3 link characteristics appropriate for the operation</p>

Design Verification Cont'd



- In addition to the MoC:
 - Organisational elements may be checked (e.g. design process, config. control)
 - May witness some tests, perform design inspections etc.
- Design Verification EASA cost guidelines: expected to not exceed 180 hrs. (except for complex projects) €233/hr. = €37,280

Design Verification

- First design verification issued
 - Volocopter for its VC200-2 for the design verification of its enhanced containment function (June 2021)



EASA NPA 2022-06



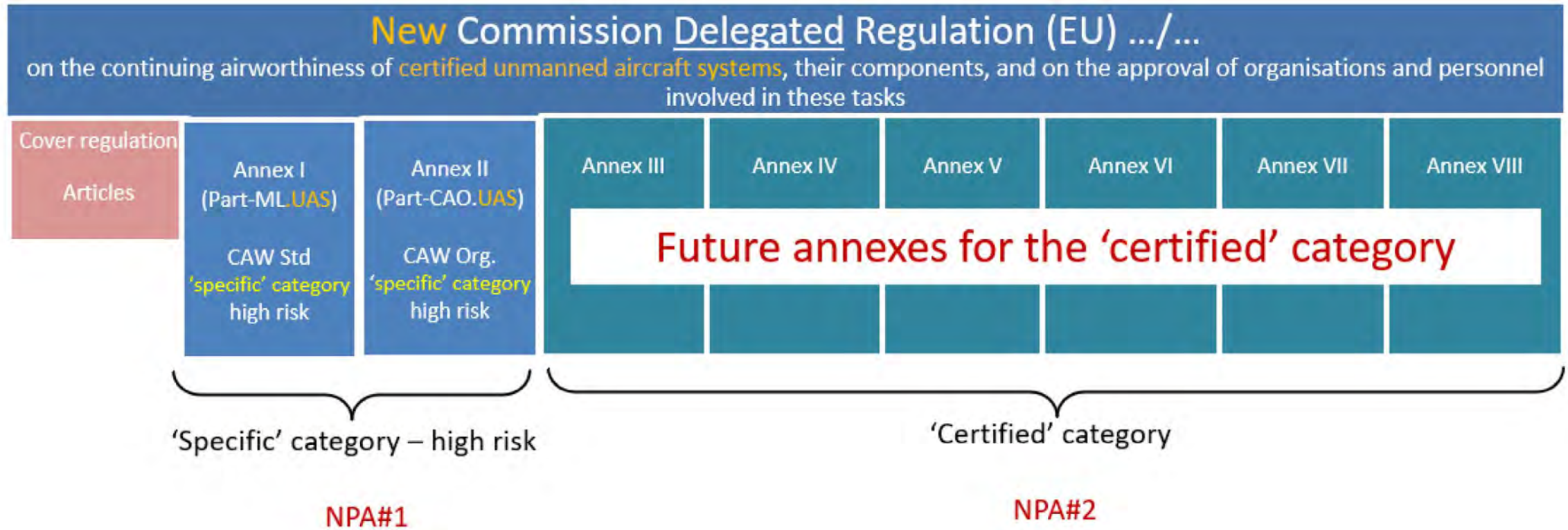
Proposes amendments to several existing EU aviation regulations and the creation of new ones to address:

- the initial airworthiness of UAS subject to certification;
- the continuing airworthiness of UAS subject to certification and which are operated in the 'specific' category;
- the operational requirements applicable to manned VTOL-capable aircraft.

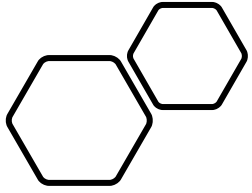
EASA NPA 2022-06



- Not included (to be addressed by the Agency with a separate NPA in the future):
 - the continuing airworthiness of UAS operated in the ‘certified’ category;
 - the operational requirements applicable to UAS (drones and unmanned VTOL-capable aircraft) operated in the ‘certified’ category.
- NPA consultation open till 30/09/2022
- Adoption Q4 2023



Delegated act (DA) on the continuing airworthiness of UAS (Draft – NPA 2022-06, 2.3.2.2)



Questions?

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