Standard Scenarios for RPAS Flight Testing in Segregated Airspace

Anastasio Sánchez

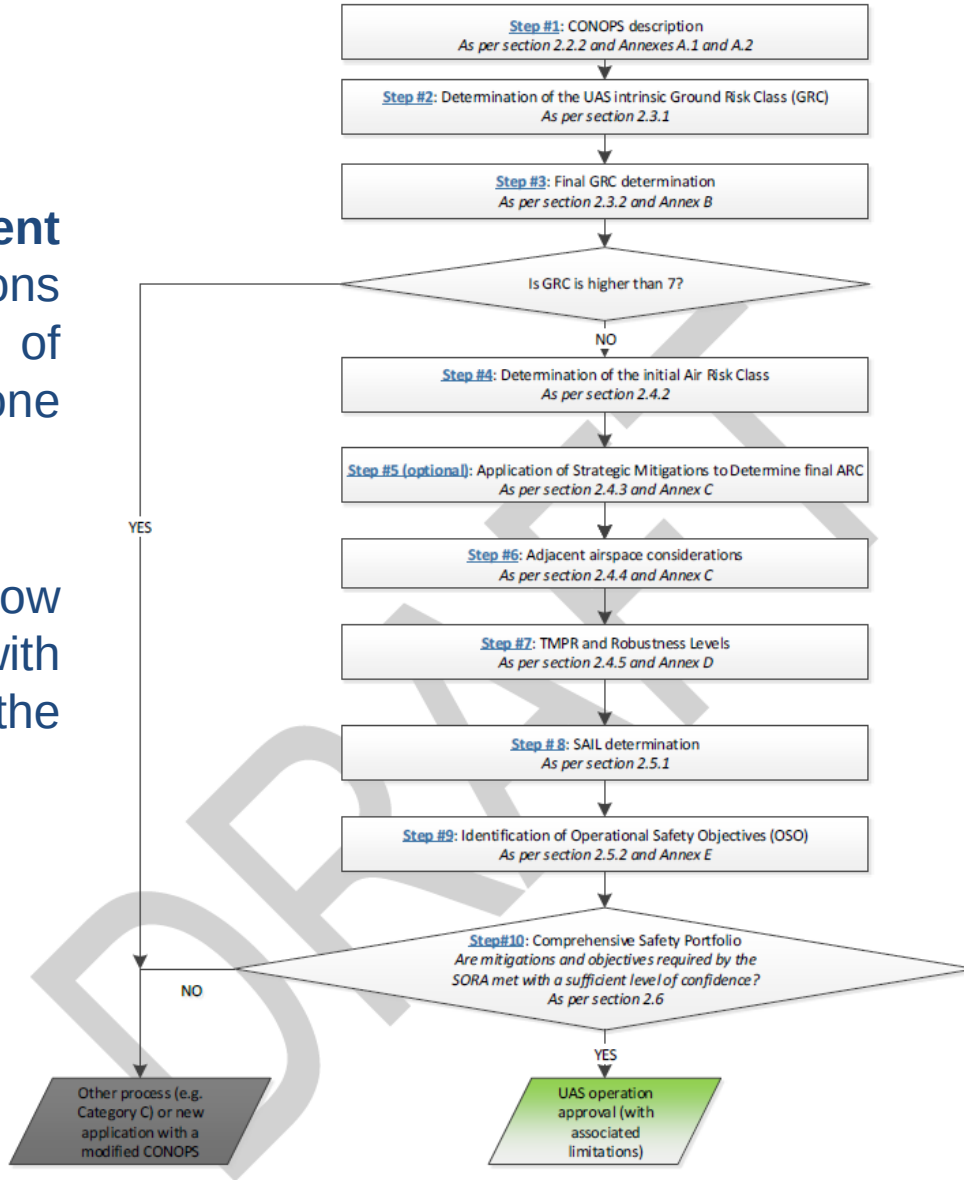
Center for Advanced Aerospace Technologies (CATEC)

SORA Methodology

WHAT IS SORA?

SORA is a **risk assessment methodology** for drone operations proposed by JARUS, the group of experts that proposes rules for the drone market.

It consists of a series of steps that allow to evaluate the risk of the operation with the drone, designed specifically for the **specific category** defined by EASA.



STANDARD SCENARIO

1- CONOPS Description

•They take place in a flight test center with segregated airspace (with an associated TSA)

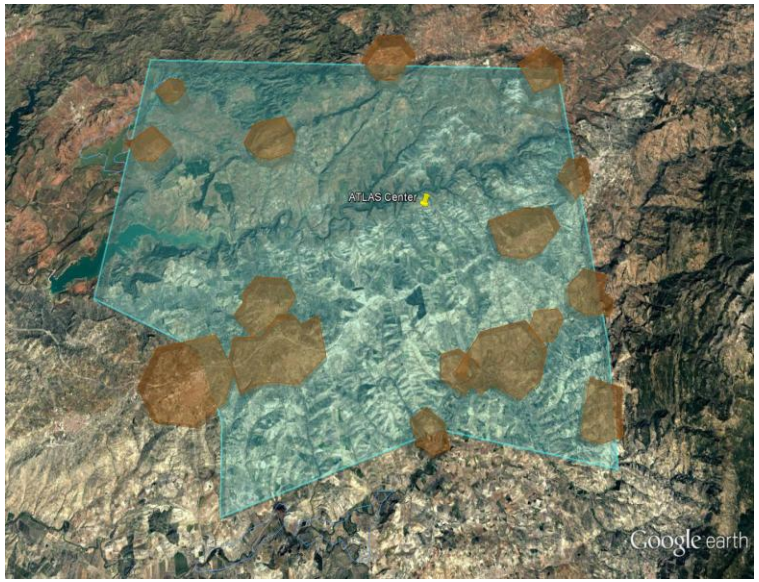
• BVLOS conditions

• Over sparsely populated areas

• Outside controlled airspace

• Out of airport environment according to the definition established in ANNEX C V1.3 section 3.11 of the SORA.

• RPAs <3m of maximum characteristic dimension (typical kinetic energy expected <34kJ).



ATLAS TSA

GROUND RISK CLASS

2- Initial GRC (unmitigated ground risk)

Intrinsic UAS Ground Risk Class				
Max UAS characteristics dimension	1 m / approx. 3ft	3 m / approx. 10ft	8 m / approx. 25ft	>8 m / approx. 25ft
Typical kinetic energy expected	*< 700 J (approx. 529 Ft Lb)*	*< 34 KJ (approx. 25000 Ft Lb)*	*< 1084 KJ (approx. 800000 Ft Lb)*	*> 1084 KJ (approx. 800000 Ft Lb)*
Operational scenarios				
VLOS over controlled area, located inside a sparsely populated environment	1	2	3	5
BVLOS over sparsely populated environment (over-flown areas uniformly inhabited)	2	3	4	6
VLOS over controlled area, located inside a populated environment	3	4	6	8
VLOS over populated environment	4	5	7	9
BVLOS over controlled area, located inside a populated environment	5	6	8	10
BVLOS over populated environment	6	7	9	11

FINAL GROUND RISK CLASS

3- Final GRC (mitigated ground risk)

Mitigation number	GRC adaptation	Robustness Level			Correction
		Low / None	Medium	High	
M1	An Emergency Response Plan (ERP) is in place, operator validated and effective	**1**	**0**	**-1**	-1
M2	Effects of ground impact are reduced	**0**	**-1**	**-2**	0
M3	Technical containment in place and effective	**0**	**-2**	**-4**	0
Total correction					**-1**

Final GRC →

	GRC
Initial	3
An effective Emergency Response Plan is available for use, and has been validated	- 1
Systems are available that reduce the effects of impact on people or land	+0
There are technical containment systems implemented and effective	+ 0
Final GRC	2

MITIGATIONS FOR GROUND RISK

Emergency response plan: high robustness level

-High Integrity level:

- ✓Proportional to risk and complexity of the operations
- ✓Define criteria to identify an emergency situation
- ✓Reduces the risk to people on gound (by limiting the “scalating effect”
- ✓Easy / effective to use
- ✓Clearly defines the roles and responsibilities of crew members
- ✓Remote pilots receive theoretical and practical training related to ERP

-High Assurance level: the adequacy of contingency and emergency procedures should be proved trough

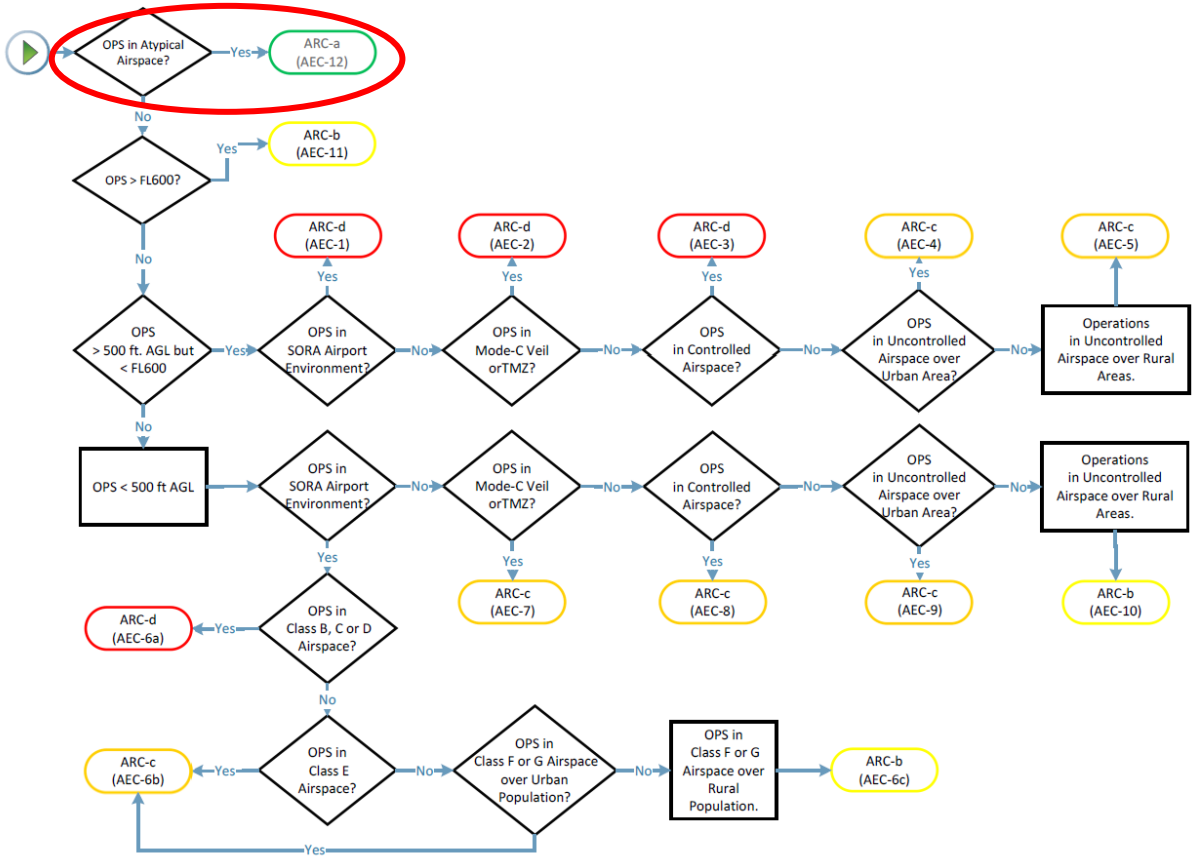
- ✓Dedicated flight tests, or,
- ✓simulations, providing its representativeness; and
- ✓the procedures, flight tests and simulations are validated by a competent third party

Reducing Ground impact: low robustness level

- Considering a small (<3m ➔ MTOW <25kg) RPAS, no parachute is considered

4- Initial ARC (aerial risk class)

-TSA: segregated airspace ➔ “atypical” airspace according to SORA Definition of Atypical Airspace in SORA Annex C V1.3, section 3.10



ARC-a

Lowest level of ARC since in segregated airspace no other airspace users are expected

AERIAL MITIGATIONS

5- Strategic Mitigation: *no need for strategic mitigations*

6- Adjacent Airspace Consideration: *F or G airspace*

Containment Objectives			
Operational Case	Final ARC is ARC-d	The final ARC is other than ARC-d and the operation is **not** conducted adjacent to ARC-d airspace	The final ARC is other than ARC-d and the operation is conducted adjacent to ARC-d airspace
Containment Robustness Level	N/A	Low	High

- Containment integrity: recommended loss of containment **≤ 1 event per 100 flight hours** (1E-2/FH)
- Containment assurance: the **operator should declare** that the mitigations in place will contain the UAS in the operation volume

AERIAL MITIGATIONS AND SAIL

7- Tactical Mitigation Performance Requirement (TMPR) and Robustness Levels Strategic Mitigation

Final ARC	Tactical Mitigation Performance Requirements (TMPR)	TMPR Level of Robustness
ARC-d	High	High
ARC-c	Medium	Medium
ARC-b	Low	Low
ARC-a	No requirement	No requirement

8- SAIL determination

Final GRC: 2

Final ARC: a

SAIL Determination				
	Final ARC			
Final GRC	a	b	c	d
1	**I**	**II**	**IV**	**VI**
2	**I**	**II**	**IV**	**VI**
3	**II**	**II**	**IV**	**VI**

OPERATIONAL SAFETY OBJECTIVES

9- Identification of Operational Safety Objectives (OSOs)

-Lowest SAIL level ➔ less demanding requirements

OSO Number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure the operator is competent and/or proven	O	L	M	H	H	H
OSO#02	UAS manufactured by competent and/or proven entity	O	O	L	M	H	H
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H
OSO#04	UAS developed to authority recognized design standards	O	O	O	L	M	H
OSO#05	UAS is designed considering system safety and reliability	O	O	L	M	H	H
OSO#06	C3 link performance is appropriate for the operation	O	L	L	M	H	H
OSO#07	Inspection of the UAS (product inspection) to ensure consistency to the ConOps	L	L	M	M	H	H
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#09	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#10	Safe recovery from technical issue	L	L	M	M	H	H
	Deterioration of external systems supporting UAS operation						
OSO#11	Procedures are in-place to handle the deterioration of external systems supporting UAS operation	L	M	H	H	H	H
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operation	L	L	M	M	H	H
OSO#13	External services supporting UAS operations are adequate to the operation	L	L	M	H	H	H
	Human Error						
OSO#14	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#15	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#16	Multi crew coordination	L	L	M	M	H	H
OSO#17	Remote crew is fit to operate	L	L	M	M	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 HMI found appropriate for the mission	O	L	L	M	M	H
	Adverse operating conditions						
OSO#21	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#22	The remote crew is trained to identify critical environmental conditions and to avoid them	L	L	M	M	M	H
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L	L	M	M	H	H
OSO#24	UAS designed and qualified for adverse environmental conditions	O	O	M	H	H	H

Many of them are *Optional* and the rest are *Low*

OSO Number (in line with Annex E)		SAIL
		I
	Technical issue with the UAS	
OSO#03	UAS maintained by competent and/or proven entity	L
OSO#07	Inspection of the UAS (product inspection) to ensure consistency to the ConOps	L
OSO#08	Operational procedures are defined, validated and adhered to	L
OSO#09	Remote crew trained and current and able to control the abnormal situation	L
OSO#10	Safe recovery from technical issue	L
	Deterioration of external systems supporting UAS operation	
OSO#11	Procedures are in-place to handle the deterioration of external systems supporting UAS operation	L
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operation	L
OSO#13	External services supporting UAS operations are adequate to the operation	L
	Human Error	
OSO#14	Operational procedures are defined, validated and adhered to	L
OSO#15	Remote crew trained and current and able to control the abnormal situation	L
OSO#16	Multi crew coordination	L
OSO#17	Remote crew is fit to operate	L
	Adverse operating conditions	
OSO#21	Operational procedures are defined, validated and adhered to	L
OSO#22	The remote crew is trained to identify critical environmental conditions and to avoid them	L
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L

COMPREHENSIVE SAFETY PORTFOLIO

10- Comprehensive Safety Portfolio

-Based on level of robustness of previous OSOs, the level of confidence is adequate so the operation can be safely conducted.

-Additional requirements to those identified by the SORA (security, environmental protection, etc.) as well as relative stakeholders (environmental protection agencies, national security bodies, etc.)

BIG DRONES

In case of bigger drones: **RPAs <8m** of maximum characteristic dimension ➔ associated to **MTOW>25kg**, the GRC would be 4 without mitigations.

In order to reach the same final GRC as in previous case so the same SAIL Level, it would be required to include a system to reduce the effect of a ground impact of medium robustness ➔ **parachute**.

APPLICATION

This risk assessment has been used for authorization application of drone flights in ATLAS in the scope of ALADDIN project

ALADDIN project

*Study, design, develop, and evaluate, a **counter drone system** as a complete solution to the growing drone threat problem, building upon a state-of-the-art system and enhancing it by researching on various **detection and neutralization technologies** (program H2020)*

ALADDIN

European Commission | Horizon 2020 European Union funding for Research & Innovation

***First authorization in Spain applying article 43 of current Spanish drone regulation** for exemption drone flights (drones flying at night without lights to represent real case scenario)*

ATLAS

ATLAS is a flight test center located in Villacarrillo, Jaen, Spain, designed for drone operations.

*ATLAS counts with a segregated airspace (**TSA**) of 1,000 km2 (30x35 km), and up to 5000 feet height AMSL.*

SUMMARY

-***SORA methodology followed for the risk assessment***

-***Analysis of operations in flight test centers in TSA (segregated areas) over sparsely populated areas***

-***GRC would depend on the size of the drones***

-***ARC has the lowest level since TSA is considered an atypical airspace, where manned aircraft cannot go***

-***Drones MTOW>25 kg would need a parachute for the same SAIL level***

-***AESA has published these standard scenarios according to this analysis***

-***ATLAS is a flight test center with a TSA which will be used for ALADDIN project***