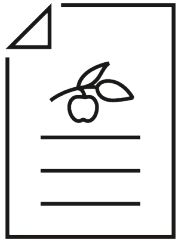
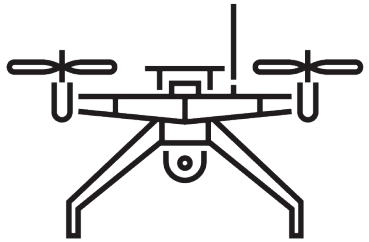
UAS safety & risk assessment

IDT 2022





Operations centric, risk-based, performance based regulation

OPEN category - Low risk

NO-PRE APPROVAL

LIMITATIONS: 25 kg, Visual Line of Sight (VLOS), height <120m, system of zones

3 Sub-categories: fly over, close, far from people

General public / recreational purpose

Model Flying, Photographers

SPECIFIC - Increased risk

Authorisation by NAA based on specific operation risk assessment (SORA)

Declaration in case of standard scenario; LUC

BVLOS operations (line inspections, aerial work, ...)

Transport of goods

CERTIFIED - Risk as manned aviation

Certification of UAS [by EASA], approval of the operator and licensed pilot (unless autonomous flight) [by the NAAs]

Air Taxi
International IFR (cargo, passengers)
Package delivery over people

In doubt?

www.droneregler.dk

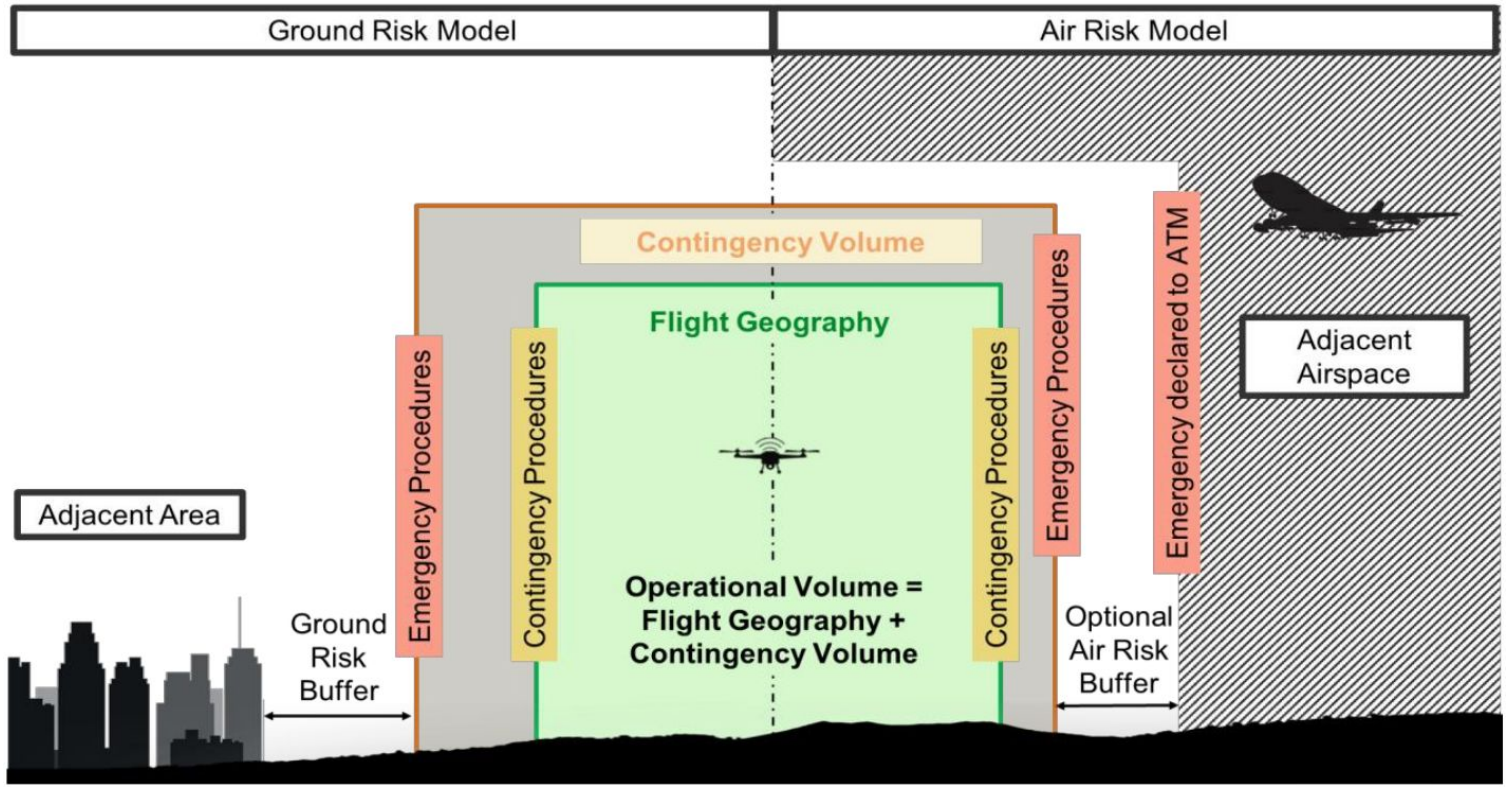
www.droneluftrum.dk

SDU UAS Center project examples

Specific Operations Risk Assessment (SORA)

- 308 pages
- pp. 35 - 70
- pp. 98 - 123

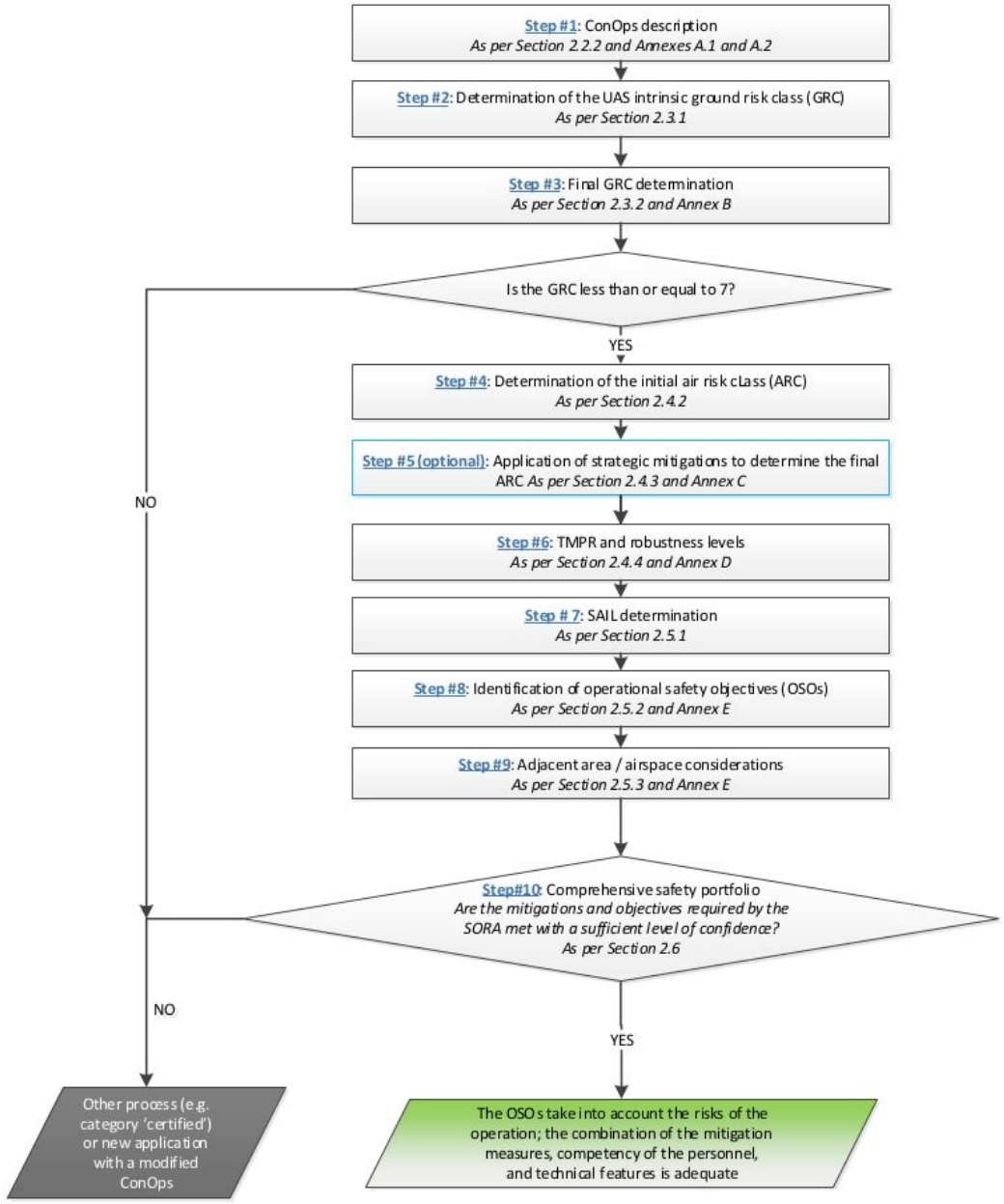
SORA semantic model



Robustness

	Low assurance	Medium assurance	High assurance
Low integrity	Low robustness	Low robustness	Low robustness
Medium integrity	Low robustness	Medium robustness	Medium robustness
High integrity	Low robustness	Medium robustness	High robustness

SORA steps

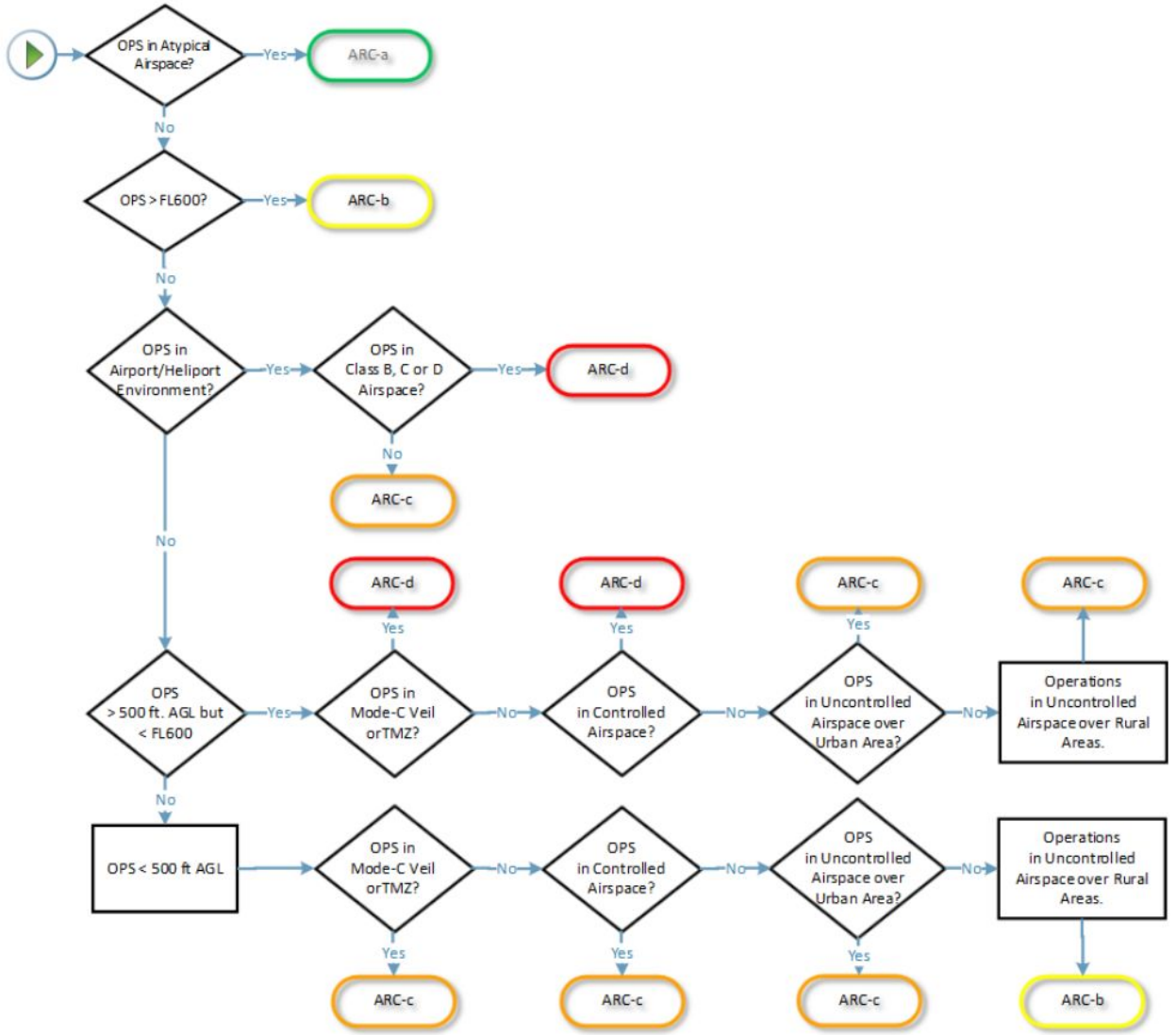

Step #1: ConOps description
As per Section 2.2.2 and Annexes A.1 and A.2
Step #2: Determination of the UAS intrinsic ground risk class (GRC)
As per Section 2.3.1
Step #3: Final GRC determination
As per Section 2.3.2 and Annex B
Is the GRC less than or equal to 7?
YES
NO
Step #4: Determination of the initial air risk class (ARC)
As per Section 2.4.2
Step #5 (optional): Application of strategic mitigations to determine the final ARC As per Section 2.4.3 and Annex C
Step #6: TMPR and robustness levels
As per Section 2.4.4 and Annex D
Step # 7: SAIL determination
As per Section 2.5.1
Step #8: Identification of operational safety objectives (OSOs)
As per Section 2.5.2 and Annex E
Step #9: Adjacent area / airspace considerations
As per Section 2.5.3 and Annex E
Step#10: Comprehensive safety portfolio
Are the mitigations and objectives required by the SORA met with a sufficient level of confidence?
As per Section 2.6
NO
YES
Other process (e.g. category 'certified') or new application with a modified ConOps
The OSOs take into account the risks of the operation; the combination of the mitigation measures, competency of the personnel, and technical features is adequate

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			

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

Air risk


OPS in Atypical Airspace?
Yes
ARC-a
No
OPS > FL600?
Yes
ARC-b
No
OPS in Airport/Heliport Environment?
Yes
OPS in Class B, C or D Airspace?
Yes
ARC-d
No
ARC-c
No
OPS > 500 ft. AGL but < FL600
Yes
OPS in Mode-C Veil orTMZ?
Yes
ARC-d
No
OPS in Controlled Airspace?
Yes
ARC-d
No
OPS in Uncontrolled Airspace over Urban Area?
Yes
ARC-c
No
Operations in Uncontrolled Airspace over Rural Areas.
ARC-c
No
OPS < 500 ft AGL
OPS in Mode-C Veil orTMZ?
Yes
ARC-c
No
OPS in Controlled Airspace?
Yes
ARC-c
No
OPS in Uncontrolled Airspace over Urban Area?
Yes
ARC-c
No
Operations in Uncontrolled Airspace over Rural Areas.
ARC-b

Specific Assurance and Integrity Level (SAIL)

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			

Operational Safety Objectives (OSOs)

OSO number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure the UAS 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 recognised design standards[1]	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 is appropriate for the operation	O	L	L	M	H	H
OSO#07	Inspection of the UAS (product inspection) to ensure consistency with 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 a technical issue	L	L	M	M	H	H
	Deterioration of external systems supporting UAS operations						
OSO#11	Procedures are in-place to handle the deterioration of external systems supporting UAS operations	L	M	H	H	H	H
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operations	L	L	M	M	H	H

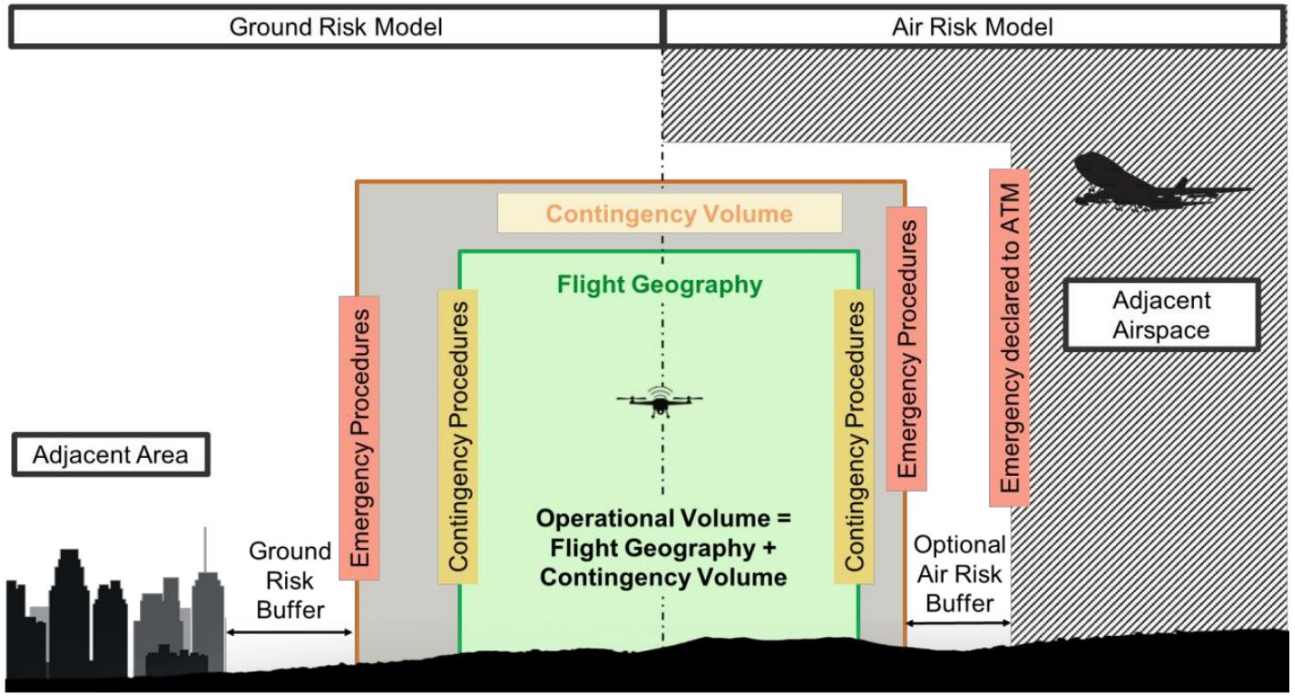
OSO number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
OSO#13	External services supporting UAS operations are adequate for the operation	L	L	M	H	H	H
	Human error						
OSO#14	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#15	Remote crew trained and current and able 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 human machine interface (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 are defined, measurable and adhered to	L	L	M	M	H	H
OSO#24	UAS is designed and qualified for adverse environmental conditions	O	O	M	H	H	H

Step #9

1. No probable[1] failure[2] of the UAS or any external system supporting the operation should lead to operation outside the operational volume.

Compliance with the requirement above shall be substantiated by a design and installation appraisal and shall include at least:

1. *the design and installation features (independence, separation and redundancy);*



Exercises

Lab report

- Short and to the point
- Answer all questions
- Look in the SORA doc, search online
- Ask for help if needed