RISKOVURDERING FOR
STANDARD SCENARIO FOR REDNINGSBEREDSKABETS
FLYVNING MED DRONER I DANMARK, DK-BER-2

SUBPART B: EXPLANATORY NOTE AND RISK ASSESSMENT FOR DK-BER-2

B-1.1. Explanatory Note

The standard scenario DK-BER-2 is intended to provide an operational frame where many of emergency preparedness operations can be performed.

The risk assessment for the DK-BER-2 scenario is based the SORA methodology developed in the JARUS organisations[1] as well the information available from EASA on the EU regulation expected to come into force for drone operations within the EU.

Next section of this document includes the SORA process applied to this scenario to show that the proposed provisions are sufficiently robust and consistent with the methodology.

[1] See JARUS SORA package on JARUS website (http://jarus-rpas.org)

B-1.2. Risk assessment based on SORA

The proposed standard scenario (scenario) is assessed following the process described in JARUS SORA V2.0 as follows:

Pre-application evaluation:

Step #1 – CONOPS description

The proposed scenario is intended to encompass all operations that can fit within the defined operational limitations.

Generally, applicants will need to provide the competent authority with their CONOPS as part of the substantiation package.

Ground Risk Process:

Step #2 – Determination of the initial UAS Ground Risk Class

The initial UAS ground risk relates to the unmitigated risk of a person being struck by the UA (in case of loss of UAS control) and can be represented by the Ground Risk Classes (GRC) derived from the intended operation and the UAS lethal area, as shown in Table B-1.1 below.

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
VLOS over gathering of people	7			
BVLOS over gathering of people	8			

Table B-1.1 – Determination of the intrinsic UAS Ground Risk Class (GRC) (source: SORA Main Body V2.0)

From the limitations defining the proposed scenario:

- Operational scenarios: VLOS over controlled area located inside a populated environment
  - Allowed to operate BVLOS when UAS is flown behind buildings, smoke, trees etc. but always at a distance were VLOS is re-established once UAS is back above the object having obscured the vision of the UAS
  - The limited BVLOS operation should in principle make this scenario a GRC 6, but given the short duration of the BVLOS operation and the higher level of risk accepted for emergency preparedness operations, GRC is maintained at 4.
- UA characteristics:
  - Up to 3m of characteristic dimension (e.g. wingspan or rotor diameter)
  - Maximum 34 kJ Kinetic Energy

Thus, the maximum Intrinsic UAS GRC, as highlighted in Table B-1.1, is:

Intrinsic GRC = 4

<u>Step #3 – Final GRC determination</u>

As indicated in SORA, s*ince mitigations used to modify the intrinsic GRC have a direct effect of the safety objectives associated with a particular operation, it is especially important to ensure their robustness. This aspect assumes extreme relevance in those cases where harm barriers are of technological nature (e.g. emergency parachute). This step of the process allows for determination of the final GRC based on the availability of these mitigations to the operation. Table B-1.2 provides a list of these mitigations and the relative correction factor. A positive number denotes an increase of the GRC while a negative number results in a decrease of the GRC. All barriers have to be considered in order to perform the assessment. Annex B of SORA provides additional details on how to estimate the robustness of each mitigation. Competent authorities may define additional mitigations and the relative correction factors*.

For this scenario, only the following mitigations for final GRC determination are considered:

- **Emergency Response Plan (ERP)** with a "high" level of robustness and, consequently:
  - Regarding integrity, the ERP should follow the SORA criteria
    - is suitable for the situation;
    - defines criteria to identify an emergency situation;
    - reduces the risk to people on the ground (by limiting the escalating effect);
    - is practical to use;
    - clearly delineates Remote Crew member(s) duties.
    - The competency-based theoretical and practical training proposed by the applicant covers the ERP and include related proficiency requirements and training recurrences.
  - Regarding assurance, the criteria for the adequacy of contingency and emergency procedures applies (see "Operator provisions – Organisation and procedures" in Table B.1-1), that is, the adequacy should be proved through:
    - ✓ dedicated flight tests, or
    - ✓ simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results
    - ✓ Any flight test performed to validate the procedures cover the complete flight envelope or be proven to be conservative.
    - ✓ The procedures, flight tests and simulations are validated by a competent third party.
    - ✓ Training syllabus validated by a competent third party.
    - ✓ Remote crew competencies verified by a competent third party

- **Technical containment** in place and effective, where:
  - the operator needs to define:
    - ✓ the operation volume, including flight geography and the containment area and
  - the remote flight crew should ensure containment of the operation so that it can be reasonably expected that the UA will stay within the containment area.

  The robustness of this mitigation is considered "low" for this scenario.

Therefore, as highlighted in Table B-1.2, the result is that there is no correction to the Intrinsic GRC and, consequently, the **Final GRC is** equal to the Intrinsic/Initial GRC, which is **3**.

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**	0
M2	Effects of ground impact are reduced	**0**	**-1**	**-2**	0
M3	Technical containment in place and effective	**0**	**-2**	**-4**	0
Total correction					**0**

Table B-1.2 – Mitigations for Final GRC determination (source: SORA Main Body V2.0)

Air Risk Process:

Step #4 – Determination of the Initial Air Risk Class

As indicated in SORA, the competent authority, ANSP, or UTM/U-space service provider, may elect to directly map the airspace collision risks using airspace characterization studies. These maps would directly show the initial Air Risk Class (ARC) for a particular airspace. If the competent authority, ANSP, or UTM/U-space service provides an air collision risk map (static or dynamic), the operator should use that service to determine the initial ARC, and skip to section 2.4.3 Application of Strategic Mitigations to reduce the initial ARC.

The following operational limitations related to the air risk are defined for this scenario:

- below 120 m in built-up area and 100 m outside built-up area to stay consistent with all other drone Danish operations operating under the regular rules;
- At least 5 km away from public airports or max 40 m above runway surface in the range 2-5 km from the airport, unless specific procedure for operations approved
- At least 8 km away from military airstations or max 40 m above runway surface in the range 2-8 km from the airstation, unless specific procedure for operations approved

- At least 2 km fra HEMS fields or max 50 m above HEMS field elevation surface in the range 1-2 km from the HEMS field, unless specific procedure for operations approved
- Outside of active restriction areas, unless specific procedure for operations approved.

Then, the Airspace Encounter Categories (AECs) and Air Risk Classes (ARCs) associated to this scenario are shown in diagram of Figure B-1.1.

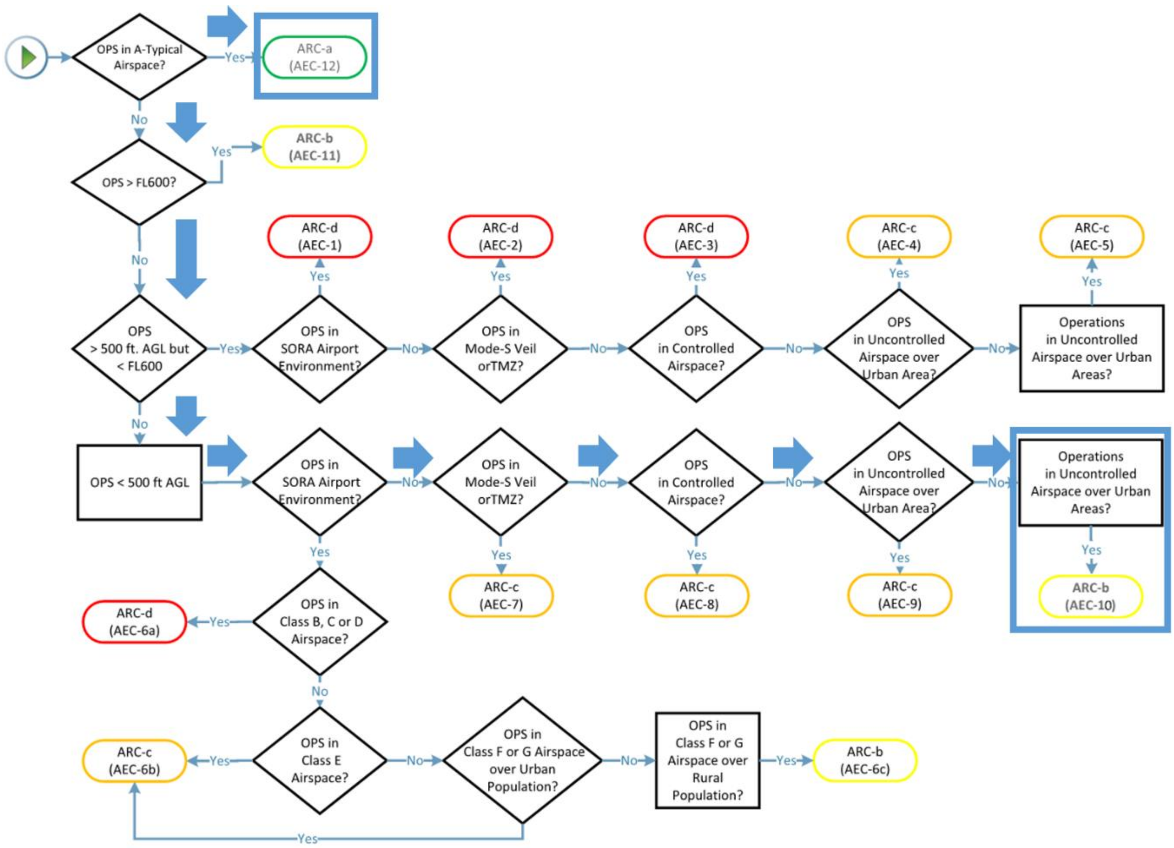

Figure B-1.1 – ARC/AEC determination process (source: adapted from SORA Main Body V2.0)

The following differences are applied compared to the standard SORA air risk model:

- In Denmark drone operations which keep the above mentioned distances are considered to be same as outside controlled airspace and hence the classification does not drive a AEC-8 classification.
- Given the higher risk accepted for emergency preparedness operations and the low traffic intensity over built-up area heights below 120 m, the ARC-c derived from the process (driving by built-up area) is changed to an ARC-b as defined by rural area

As a special case of this scenario operations within the airport/HEMS areas defined above can be allowed if suitable tactical mitigation is applied and approved by the DTCA.

Therefore, operations under this scenario would have an ARC-b (with AEC-10), as defined in SORA Annex C.

Step #5 – Application of Strategic Mitigations to determine Final ARC (optional)

No credit from strategic mitigations is taken for this scenario. For this reason, the ARC becomes the final ARC:

Final ARC = ARC-b

Step #6 – Adjacent Airspace Considerations

The objective of this step is to address the risk posed by a loss of control of the operation resulting in an infringement of the adjacent airspace.

The provision of the distance requirements to airport and HEMS fields as defined in Step #5 is in Denmark considered acceptable means of addressing adjacent airspace without increasing the air risk.

Since the adjacent area has an ARC different to ARC-d and the Final ARC is ARC-b, the containment objectives require a **low containment robustness level**, as indicated in Table B-1.3.

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

Table B-1.3 – Robustness Levels for Containment Objectives (source: SORA Main Body V2.0)

SORA Annex C proposes the following criteria for low robustness level for containment:

- Containment integrity: recommended loss of containment **≤ 1 event per 100 flight hours** (1E-2/FH)

  This recommendation has been included in the operational mitigations for this scenario.

- Containment assurance: the **operator should declare** that the mitigations in place will contain the UAS in the operation volume.

  For this scenario, as it is **subject to authorization** by the competent authority, the operator will have to **provide evidence** of the planned mitigations and that those can reasonably expected to meet the containment integrity objective.

Therefore, it can be concluded that the **proposed provisions for this scenario comply with the SORA criteria for low robustness level for containment**.

Step #7 – Tactical Mitigation Performance Requirement (TMPR) and Robustness Levels

Since no strategic mitigation is considered for this scenario (see Step #5), all mitigation measures addressing the air risk are tactical.

As indicated in Table B-1.4 below, the required level for Tactical Mitigation Performance Requirement (TMPR) and TMPR robustness is **low**.

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

Table B-1.4 – Tactical Mitigation Performance Requirement (TMPR) and TMPR Level of Robustness Assignment (source: SORA Main Body V2.0)

The proposed provisions for this scenario are compliant with the following principle indicated in SORA for low TMPR: *operations with a low TMPR are supported by technology that is designed to aid the pilot in detecting other traffic, but which may be built to lesser standards. For example, for operations below 500ft, the traffic avoidance manoeuvres are expected to mostly be based on a rapid descend to an altitude where manned aircraft are not expected to ever operate*.

The following two categories of tactical mitigations and corresponding TMPR described in SORA are considered for this scenario:

- TMPR using human "See and Avoid" schemas (e.g. VLOS, "EVLOS")
    - A **VLOS limitation is included in this scenario for launch/take-off & recovery/land phases**. However, this provision is meant mainly as a mitigation for the ground risk (e.g. to allow the remote pilot to take immediate action if he/she sees an abnormal behavior of the UA or an unforeseen obstacle). Nevertheless, it can also be used as an additional mitigation for the air risk (e.g. to abort launch/take-off if an incoming traffic is detected) even if at the flight heights where those phases take place it is unlikely to pose a significant risk to other airspace users when operating away from aerodromes, etc.
    - The following limitations are included, that can be considered as "BVLOS" limitations in accordance to SORA definition[2] (but operations will be anyway considered BVLOS, as per SORA approach[3]):

[2] SORA considers the following definition: "*EVLOS operation: A UAS operation whereby the Pilot in Command (PIC) maintains an uninterrupted situational awareness of the airspace in which the UAS operation is being conducted via visual airspace surveillance, possibly aided by technology means. The PIC has a direct control of the UAS at all time.*"
[3] E.g., SORA indicates that "*EVLOS operations are to be considered as BVLOS for the GRC determination*"

- ✓ UA is **not operated at more than 1 Km from the remote pilot**.

- TMPR using alternate means of mitigation to human “See and Avoid” schemas

  Alternate means of mitigation implies that machine or machine-assisted Separation and Collision Avoidance schemes are used (e.g. ATC Separation Services, TCAS, DAA, UTM, U-Space, etc.)

  In this scenario, some provisions taken from SORA criteria are included for those operations where machine-based mitigations are planned to be used, as indicated in Table B-1.5.

Regarding performance requirements for the “detect and avoid” functions, Table B-1.5 below shows TMPR for ARC-b (TMPR Low) and TMPR considered in proposed mitigations for the scenario.

		Tactical Mitigation Performance Requirements (TMPR)	
		In SORA for ARC-b (TMPR Low)	**In proposed mitigations for the scenario**
Functions	Detect	The expectation is for the applicant's DAA Plan to enable the operator to **detect approximately 50% of all aircraft in the detection volume**[4]. It is required that the **applicant has awareness of most of the traffic operating in the area** in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM[5]/Pilot Aware[4] aircraft trackers • Use of UTM Dynamic Geofencing[6] • Monitoring aeronautical radio communication (i.e. use of a scanner)[7]	The limitation of **not having the UA operating further than 1 Km** from the remote pilot or a VO, allows the remote flight crew to **scan the airspace** where the UA is flying in, which can reasonably expected to enable the operator to **detect at least 50% of all aircraft in the detection volume**. No specific means for tactical mitigation are indicated in the scenario but provisions in case of their use are included (see "integrity requirements")
Functions	Decide	The operator must have a **documented de-confliction scheme**, in which the operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing a 3NM boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'LAND! LAND! LAND!'	Operating procedures should be documented, which include the contingency procedures containing the de-confliction scheme. This de-confliction scheme should include the following aspects for the decision-making process: • Decision criteria: if the incoming traffic is detected at 3 NM (~5.6 km) or less and at 1000 ft (~300 m) or less, the avoidance manoeuvre should be initiated. • Pre-defined phraseology to warn the remote pilot in case the detection is performed by a VO, e.g. 'LAND! LAND! LAND!'
Functions	Avoid	Avoidance may rely on vertical avoidance manoeuvring or getting to a 'safe state,' the aircraft could descend from its operating altitude to the 'safe state' in less than a minute. For example, in VLL airspace, the UAS could descend to an altitude not higher than the nearest trees, buildings or ground. The following are suggested minimum performance criteria: • **Rate of climb/descend: ≥ 500 ft/min**	The minimum performance criteria from SORA is considered as technical provision for UAS in this scenario: UA should have a **maximum descent rate not less than 2.5 m/s** (500 fpm) Complying with this provision is expected to be sufficient to allow the UA descent from a flight lower than 150 m (500ft) to a 'safe state' (flight level not higher than the nearest trees, buildings or ground/water surface) in less than a minute.

	Feedback Loop	Where **electronic means assist the remote pilot in detecting traffic**, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed **3 NM threshold, a 5 second update rate and a latency of 10 seconds** is considered adequate (see example below). The **latency of the whole command (C2) link**, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the comment must **not exceed 5 seconds**.	The criteria from SORA are considered part of the technical provisions for the UAS and supporting means, in particular: • Where an **electronic means is used to assist the remote pilot and/or VOs in being aware of UA position in relation to potential "airspace intruders"**, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed 3 NM threshold, a **5 second update rate and a latency of 10 seconds** is considered adequate. • The **UAS design** should be adequate to ensure that the **time required** between a command is given by the remote pilot and the UA executes it **does not exceed 5 section.**

Table B-1.5 – SORA TMPR for ARC-b (low level) and TMPR of proposed mitigations in the scenario (source: based on SORA V2.0)

Regarding integrity requirements, the following SORA criteria has been considered as part of the technical provisions for UAS and supporting means: "the **failure of any tactical mitigation** system used as air risk mitigation, due to all causes, should **not occur more often than 1 per 100 flight hours** (1E-2)".

Therefore, considering all above, it can be concluded that the **proposed provisions for this scenario comply with the SORA criteria for low TMPR and associated robustness level**.

[4] The size of the detection volume depends on the aggravated closing speed of traffic that may be reasonably be encountered, the time required by the remote pilot to command the avoidance manoeuvre, the time required by the system to respond and the manoeuvrability and performance of the aircraft. The detection volume is proportionally larger than the alerting threshold.
[5] FLARM and PilotAware are commercially available (trademarked) products/brands. They are referenced here only as example technologies. The references do not imply an endorsement by JARUS or the authors of this document for the use of these products. Other products offering similar functions may also be used.
[6] These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today. A subscription to these services may be required.
[7] If permitted by the authority. May require a Radio-License or Permit.

Final SAIL and Operational Safety Objectives (OSO) Assignment

Step #8 – SAIL determination

Considering that:

- Ground risk: final GRC is 3.
- Air risk: final ARC is ARC-b

Then, the resulting **SAIL for this scenario is II**, as indicated in Table B-1.6 below:

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**
4	**III**	**III**	**IV**	**VI**
5	**IV**	**IV**	**IV**	**VI**
6	**V**	**V**	**V**	**VI**
7	**VI**	**VI**	**VI**	**VI**
>7	Category C (certified) operation			

Table B-1.6 – SAIL determination (source: SORA Main Body V2.0)

Step #9 – Identification of Operational Safety Objectives (OSOs)

As indicated in SORA:

- The purpose of this step is to evaluate the defenses within the operation in form of operational safety objectives (OSOs) and the associated level of robustness depending on the SAIL.
- Table B-1.7, from SORA, provides a qualitative methodology to make this determination. In this table, O is Optional, L is recommended with Low robustness, M is recommended with Medium robustness, H is recommended with High robustness. The various OSOs are grouped based on the threat they help to mitigate. Some OSOs may therefore be repeated in the table.
- Table B-1.7 provides a consolidated list of common OSOs that have been historically used to ensure safety of UAS operations. It collects the experience of many experts and is therefore a solid starting point to determine the required safety objectives for a specific operation. Competent authorities may define additional OSOs and the relative level of robustness.

SAIL II corresponding to this scenario is highlighted in Table B-1.7 to show the required level of robustness for the different OSOs

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[8]	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

[8] The robustness level does not apply to mitigations for which credit has been taken to derive the risk classes. This is further detailed in para. 3.2.11(a).

OSO Number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
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

Table B-1.7 – Recommended operational safety objectives (OSOs) (source: SORA Main Body V2.0)

Step #10 – Comprehensive Safety Portfolio

This step addresses the satisfactory substantiation of mitigations and objectives required by the SORA process, ensuring also that any additional requirements to those identified by the SORA process (e.g. security, environmental protection, etc.) as well as the relative stakeholders (e.g. environmental protection agencies, national security bodies, etc.) are adequately addressed.

For the purpose of the assessment of this scenario, under this step the compliance of proposed provisions for the scenario against SORA criteria is performed as shown in Table B-1.8 with the following additional considerations:

- The protection of privacy which is included in the Danish drone regulation yields, as specified in the scenario, to the purpose of emergency preparedness operations under this scenario
- Some security measures which are included in the Danish drone regulation yields, as specified in the scenario, to the purpose of emergency preparedness operations under this scenario.

<table>
<tr><th colspan="2">Operational Safety Objectives (OSOs)</th><th>SAIL II expected level of robustness</th><th>Criteria in SORA for SAIL II</th><th>Provisions for the scenario</th></tr>
<tr><td rowspan="2">OSO #01 – Ensure the operator is competent and/or proven</td><td>LEVEL of INTEGRITY</td><td rowspan="2">Low</td><td>The operator needs to have knowledge of the used UAS and have relevant operational procedures including at least: checklists, maintenance, training, responsibilities, and duties.</td><td>General provisions for UAS operators:
• The UAS operator should:
1. Establish for the personnel under its responsibility:
(a) the responsibilities and duties and,
(b) the required level of competencies, training and assessment or qualification for the remote flight crew.
2. Have a good knowledge on the UAS and supporting means planned to be used in the intended operations. For this purpose, the UAS operator should ensure having all the relevant documentation
• Standard Operating Procedures (SOP)
• Maintenance procedures
Specific provisions for this scenario with regard to abovementioned aspects are included in Subpart A, sec. A.1.3.</td></tr>
<tr><td>LEVEL of ASSURANCE</td><td>Self-evaluation by the operator</td><td>No explicit “level of assurance” is indicated for the level of knowledge of the operator in the used UAS (and supporting means), so it is assumed that it is sel-evaluated by the operator.</td></tr>
</table>

<table>
<tr><th colspan="2">Operational Safety Objectives (OSOs)</th><th>SAIL II expected level of robustness</th><th>Criteria in SORA for SAIL II</th><th>Provisions for the scenario</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Regarding operating procedures (included in the SOPs) and maintenance procedures, these should at least documented (as indicated in the corresponding OSOs) and, consequently, should be available for the competent authority.</td></tr>
<tr><td rowspan="2">OSO #03 – UAS maintained by competent and/or proven entity (e.g. industry standards)</td><td>LEVEL of INTEGRITY</td><td rowspan="2">Low</td><td>• The UAS maintenance procedures are defined and cover at least the UAS designer instructions and requirements.
• The maintenance team (i.e. the personnel authorized to conduct maintenance on the UAS in line with the maintenance procedures) is defined.</td><td>General provisions for UAS:
• Maintenance procedures, should cover, at least, the manufacturer’s instructions and provisions
• Maintenance team, which should be:
○ established by the UAS operator;
○ limited to the personnel authorized by the UAS operator to conduct maintenance tasks, in accordance with the maintenance procedures</td></tr>
<tr><td>LEVEL of ASSURANCE</td><td>• Criterion #1 (Procedure):
○ The maintenance procedures are documented.
○ The maintenance conducted on the UAS are document in a maintenance log [(1) (2)]
[(1)] Designer instructions and requirements may include description of maintenance action that needs to be logged.</td><td>General provisions for UAS operators:
• Maintenance procedures should:
○ be documented; and
○ include registering the maintenance activities in a log, which should be available to the competent authority on request
• Maintenance team, which should be adequately trained and qualified</td></tr>
</table>

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the scenario**
			[(2)] *The maintenance log may be requested for inspection by the approving authority or an authorized representative.* • Criterion #2 (Training): The maintenance team is self-trained to maintenance procedures.	
OSO #06 – C3 link performance is appropriate for the operation	LEVEL of INTEGRITY	Low	• The applicant determines that performance, RF spectrum usage [(1)(2)] and environmental conditions for C3 links are adequate to conduct safely the intended operation. [(1)] *For a low level of integrity, unlicensed frequency bands might be accepted under certain conditions, e.g.:* ○ *the applicant demonstrates compliance with other RF spectrum usage requirements (e.g. for EU: Directive 2014/53/EU, for US: CFR Title 47 Part 15 Federal Communication Commission (FCC) rules), for instance by showing that the UAS pieces of equipment are compliant with these requirements (e.g. FCC marking), and*	• General provisions for UAS that normal procedures should cover: (1) *Operation preparation and planning*, including the **assessment of**: iii. **environmental conditions** (before and during the operation) vi. the **UAS and any other technical means** to be used in the operation, including the assessment of their suitability and their fitness (e.g. airworthy condition) and compliance with **required performance** (e.g. **required C2 link performance**) for a safe conduct of the intended operation. vii. compliance with any specific requirement from the relevant authorities in the intended area of operations, including those related to security, privacy, environmental protection, **use of RF spectrum**, etc. • Technical provisions which include that:

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
			○ *the use of protection mechanisms against interference (e.g. FHSS, frequency deconfliction by procedure).* • The UAS remote pilot has the means to continuously monitor the performance of C3 to ensure the adequacy of that performance to the operation requirements [(3)]. [(3)] *The remote pilot has access at all times and in a timely manner to the relevant information on C3 affecting the safety of flight. For the operations requesting only a low level of integrity for this OSO, this could be limited to monitoring the C2 link signal strength and receiving an alert from the UAS HMI if the signal is becoming too low.*	○ **Means** should be provided to **continuously monitor the performance of C2 Link and any other communications** affecting the safety of operations, to ensure the adequacy of that performance to the operation requirements. • In the specific technical provisions for this scenario: ○ **Means to monitor critical parameters** for a safe flight should be available, in particular: ▪ status of critical functions and systems (e.g. **C2 Link**, GNSS …); as a minimum, for services based on **RF signals** (e.g. C2 Link, GNSS …) means should be provided to **monitor the signal strength** and **triggering an alert** if level is becoming too low. ○ The UAS should **comply with the requirements for radio equipment** and the **use of RF spectrum**. ○ **Protection mechanisms against interference should be used,** especially if unlicensed bands (e.g. ISM) are used for C2 Link (mechanisms like Frequency Hopping Spread Spectrum – FHSS, technology or frequency deconfliction by procedure)

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
	LEVEL of ASSURANCE		The applicant declares that the required level of integrity has been achieved [(1)] *[(1)]Supporting evidences may or may not be available*	Under this generic scenario, subject to authorisation, it is expected that a most aspects indicated for the "level of integrity" can be substantiated, at least, at descriptive level. For example: procedures including assessment of UAS, environmental conditions, …; manufacturer's documentation showing compliance with requirements for radio equipment and the use of RF spectrum; etc.
OSO #07 Inspection of the UAS (product inspection) to ensure consistency to the ConOps	LEVEL of INTEGRITY	Low	The remote crew performs pre-flight inspection to ensure the UAS is in a condition for safe operation and conforms to the approved concept of operations.	General provisions for UAS: (2) **Pre-flight inspection procedures**, which should be: i. performed by the remote flight crew to ensure the UAS is in a condition for safe operation and conforms to the concept of operations (CONOPS)
	LEVEL of ASSURANCE		• Criterion #1 (Procedure): Pre-flight inspection procedure is documented • Criterion #2 (Training):The maintenance team is self-trained to maintenance procedures.	• General provisions for UAS operators in Subpart A of EU-scenario contains provisions for operational procedures in sec. 4.1.2.2, which include in 1(a) that normal procedures should cover: (2) **Pre-flight inspection procedures**, which should be: ii. **documented** (at least as part of the manufacturer's instructions and requirements)

<table>
<tr><th colspan="2">Operational Safety Objectives (OSOs)</th><th>SAIL II expected level of robustness</th><th>Criteria in SORA for SAIL II</th><th>Provisions for the scenario</th></tr>
<tr><td></td><td></td><td></td><td></td><td>• General provisions for UAS operators in Subpart A of EU-scenario contains provisions for maintenance in sec. 4.1.5, including: maintenance team, which should be adequately trained and qualified</td></tr>
<tr><td>Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)</td><td>LEVEL of INTEGRITY</td><td>Medium</td><td>• Criterion #1 (Procedure definition):
○ Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements:
▪ Flight planning,
▪ Pre and post-flight inspections,
▪ Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),
▪ Procedures to cope with adverse operating conditions (e.g. what to do in case icing is encountered during the operation, when the operation is not approved for icing conditions)
▪ Normal procedures,
▪ Contingency procedures (to cope with abnormal situations),</td><td>• Criterion #1 (Procedure definition):
○ General provisions for UAS operators :
▪ (a) Normal procedures, including: (1) Operation preparation and planning (including the assessment of environmental conditions), (2) Pre-flight inspection procedures, (3) Launch & (normal) recovery procedures, (4) (Normal) In-flight procedures, (5) post-flight (after recovery) procedures (including the corresponding inspections)
▪ (b) Contingency procedures (to cope with abnormal situations)
▪ (c) Emergency procedures (to cope with emergency situations)
▪ (d) Occurrence reporting procedures
○ In the specific provisions this scenario regarding UAS operators – organisation and procedures:
▪ At least the following should be documented:</td></tr>
</table>

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
			▪ Emergency procedures (to cope with emergency situations), and ▪ Occurrence reporting procedures. ○ Normal, Abnormal and Emergency procedures are compiled in an Operation Manual. ○ The limitations of the external systems supporting UAS for safe operations are defined in an Operation Manual. • Criterion #2 (Procedure complexity which could jeopardize adherence to): Operational procedures involve the remote pilot to take manual control(1) when the UAS is usually automatically controlled. • Criterion #3 (Consideration of Potential Human Error): Operational procedures take considerations of human errors. *Comments / Notes*: (1) *This is still under discussion since not all UAS have a mode where the pilot could directly control the surfaces; moreover, some people claims it requires significant skill not to make things worse.*	✓ **operational procedures** ✓ environmental conditions required for a safe operation, and ✓ **limitations of the external systems** supporting UAS for safe operations. ▪ The **Standard Operating Procedures (SOP)** should be **included in an Operations Manual** or equivalent document, at least in the case that: ✓ the intended operations are **specialised operations (SPO)** or **3rd party training operations**, and ✓ the personnel involved in operations includes more than one person. • Criterion #2 (Procedure complexity which could jeopardize adherence to): [Not included, still under discussion in JARUS] • Criterion #3 (Consideration of Potential Human Error): General provisions for UAS operators in Subpart A of EU-scenario contains provisions for operational procedures in sec. 4.1.2.2, which indicates: 3. Operational procedures should take into consideration **potential human errors** and, as a minimum, provide:

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the scenario**
				(a) a clear distribution and assignment of tasks, and (b) an internal checklist to ensure staff are performing their assigned tasks.
	LEVEL of ASSURANCE		• Operational procedures are validated against recognized standards. • The adequacy of adequacy of the Contingency and Emergency procedures is proved through: ○ Dedicated flight tests, or ○ Simulation, provided that the representativeness of the simulation means is proven for the intended purpose with positive results.	In the specific provisions for this scenario regarding UAS operators – organisation and procedures: • Operational procedures should be **validated against recognised standards**. • The **adequacy** of the **contingency and emergency procedures** should be proved through: ○ Dedicated **flight tests**, or ○ **Simulations**, provided that the representativeness of the simulation means is proven for the intended purpose with positive results.
Remote crew training (OSO #09, OSO #15 and OSO #22)	LEVEL of INTEGRITY	Low	The competency-based theoretical and practical training should consist of the following elements: • Basic competencies from the competency framework necessary to ensure a safe flight: a) Application of operational procedures (normal, contingency and emergency	• General provisions for remote flight crew training and qualification: ○ The Competency Based Training (CBT) should consist of the following competencies from the competency framework necessary to ensure a safe flight:

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
			procedures, flight planning, pre-flight and post-flight inspections…) b) Communication c) RPA flight path management, automation d) Leadership, teamwork and self-management e) Problem solving and decision-making f) Situational awareness g) Workload management h) Coordination and handover • Familiarization with CAT B (Specific Category) • A rating training specific for the operation.	a) Application of operational procedures (normal, contingency and emergency procedures, flight planning, pre-flight and post-flight inspections…) b) Communication c) UA flight path management, automation d) Leadership, teamwork and self-management e) Problem solving and decision-making f) Situational awareness g) Workload management h) Coordination and handover ○ The CBT should also contains familiarization with the specific category of operations and rating training specific for each type of intended operation ○ The assessment should be done through multiple observation that competencies for a given scenario are demonstrated while performing tasks in context. • In the specific provisions for this scenario regarding training of the remote flight crew:

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
				As a minimum, the training of the remote pilot should consider the following objectives: (a) understand the safety risks linked with a UAS operation in close proximity to uninvolved people or with a heavier UA; (b) be able to assess the ground risk related to the environment where the operation takes place, as well as to flying in proximity to uninvolved people; (c) have a basic knowledge of how to plan a flight and define contingency procedures; (d) understand how environmental conditions may affect the operation; and (e) be able to maintain control of the UA at all times in a manner that ensures the successful outcome of a procedure or manoeuvre.
	LEVEL of ASSURANCE		Training is self-declared (with evidence available)	• General provisions regarding remote flight crew training: 2. For standard scenarios subject to authorisation: (a) the UAS operator and a **training organisation or entity recognised by the competent authority** should define together the training and the required level of performance;

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
				(c) the UAS operator should **present to the competent authority for approval the defined training and required level of performance indicated** in (a) • In the specific provisions for this scenario regarding training of the remote flight crew: Training should be **documented** (at least the training syllabus should be available)
Safe Design: OSO #10 Safe recovery from technical issue & OSO #12 The UAS is designed to manage the deterioration of external systems supporting UAS operation	LEVEL of INTEGRITY	Low	• No probable[1] failure[2] of the UAS or any external system supporting the operation **leads to operation outside of the operation volume**[3]. • It can be reasonably expected that a **fatality will not occur** from any probable failure of the UAS or any external system supporting the operation. *(1) The term "probable" needs to be understood in its qualitative interpretation, i.e. "Anticipated to occur one or more times during the entire system/operational life of an item."* *(2) Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed to aviation industry best practices.*	Technical (general) provisions: As a minimum, the design of a UAS and of any other safety-relevant means to be used in the intended operations (e.g. external system supporting the operation, as indicated in sec. 4.1.2) should be such that a **probable failure will not**: • **lead to the UA flying outside of the operation volume;** • **cause a fatality**. *Comments / Notes*: *1. The term "probable" needs to be understood in its qualitative interpretation, i.e. "anticipated to occur one or more times during the entire system/operational life of an item."*

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the scenario**
			[(3)] *Temporary excursions outside of the operation volume could be negotiated on a case-by-case basis*	*2. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed to aviation industry best practices.*
	LEVEL of ASSURANCE		A **design and installation appraisal** is available. In particular, the design and installation features (independence, separation and redundancy) allowing to meet the low integrity criteria are explained.	In the specific provisions for this scenario regarding technical provisions for UAS and supporting means: A **design and installation appraisal** should be made available, highlighting the design features (such as redundant components, independent back-up systems, etc.) for a "safe design", as indicated in Subpart A – section 4.3.1.
OSO #13 **External services supporting UAS operations are adequate to the operation**	LEVEL of INTEGRITY	Low	The applicant ensures that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. Roles and responsibilities between the applicant and the external service provider are defined.	General provisions external services: When UAS operations are supported by services that affect the safety of those operations and are provided by a third party (external service provider), the UAS operator should ensure that: (a) the level of performance of the service is adequate for the intended operation, and (b) the roles and responsibilities between the UAS operator and the service provider are clearly defined..

<table>
<tr><th colspan="2">Operational Safety Objectives (OSOs)</th><th>SAIL II expected level of robustness</th><th>Criteria in SORA for SAIL II</th><th>Provisions for the scenario</th></tr>
<tr><td></td><td>LEVEL of ASSURANCE</td><td></td><td>The applicant declares that the requested level of performance for any externally provided service necessary for the safety of the flight is achieved (without evidence being necessarily available)</td><td>In the specific provisions for this scenario regarding external services:
If external services are used that are necessary for the safety of operations, substantiation should at least include a declaration by the UAS operator that the required level of performance of those services is achieved.</td></tr>
<tr><td>OSO #16 Multi crew coordination</td><td>LEVEL of INTEGRITY</td><td>Low</td><td>• Criterion #1 (Procedures): Procedure(s) to ensure a coordination between the crew members with robust and effective communication channels is (are) available and covers at minimum:
○ assignment of tasks to the crew,
○ establishment of a step-by-step communication.
• Criterion #2 (Training): Remote Crew training covers multi crew coordination.</td><td>General provisions regarding multi-crew cooperation (MCC):
In all standard scenarios where MCC might be required, the UAS operator should:
• include in the SOP procedures to ensure a coordination between the remote flight crew members with robust and effective communication channels. Those procedures should cover at minimum:
(a) assignment of tasks to the remote flight crew members,
(b) establishment of a step-by-step communication
• ensure that the training of remote flight crew covers MCC.</td></tr>
</table>

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
	LEVEL of ASSURANCE		• Criterion #1 (Procedures): See "level of assurance" for Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)" • Criterion #2 (Training): see the "level of assurance" for Remote crew training (OSO #09, OSO #15 and OSO #22)"	• Criterion #1 (Procedures): see the "level of assurance" for Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)" • Criterion #2 (Training): see the "level of assurance" for Remote crew training (OSO #09, OSO #15 and OSO #22)"
OSO #17 Remote crew is fit to operate	LEVEL of INTEGRITY	Low	The applicant has a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.	General provisions regarding remote crew fit to operate: The UAS operator should establish a policy for remote flight crew declaration of being fit to operate before conducting any operation.
	LEVEL of ASSURANCE		The remote crew declare they are fit to operate before conducting any operation based on the policy defined by the applicant.	General provisions for remote flight crew regarding being fit to operate: Before conducting any operation, the remote crew should declare they are fit to operate based on the policy defined by the UAS operator.
OSO #20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission	LEVEL of INTEGRITY	Low	The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation. ○	Technical (general) provisions in Subpart A of EU-scenario contains provisions for "Human Machine Interface (HMI)" (sec. 4.3.2), namely: The UAS information and control interfaces should be clearly and succinctly presented and should not confuse, cause unreasonable fatigue, or contribute to

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the scenario**
				remote flight crew error that could adversely affect the safety of the operation.
	LEVEL of ASSURANCE		The applicant conducts an evaluation of the UAS considering and addressing human factors to determine the HMI is appropriate for the mission. The Human-Machine Interface evaluation is based on Engineering Evaluations or Analyses.	General provisions for UAS operators in Subpart A of EU-scenario contains provisions for operational procedures in sec. 4.1.2.2, which include in 1(a) that normal procedures should cover: (1) *Operation preparation and planning*, including the **assessment of**: vi. the **UAS and any other technical means** to be used in the operation, including the **assessment of their suitability** and their fitness (e.g. airworthy condition) and compliance with required performance (e.g. required C2 link performance) for a safe conduct of the intended operation. Therefore, the UAS operator should assess the suitability of UAS and any other technical means for a safe conduct of the intended operation, including the corresponding HMI.
OSO #23 Environmental conditions for safe operations	LEVEL of INTEGRITY	Low	• Criteria #1 (Definition) Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document.	General provisions • Technical provisions for documentation, which includes:

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the scenario**
defined, measurable and adhered to			• Criteria #2 (Procedures) Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple record system. • Training covers assessment of meteorological conditions	Description of the UAS/supporting means, containing at least the information indicated in section A.2 (“Guidance for collection and presentation of technical relevant information”) of SORA Annex A. SORA Annex A addresses the provision of information of environmental conditions for safe operations (e.g. weather conditions, electromagnetic environment …) • Provisions for operational procedures, which include: 2. Operational procedures should include the evaluation of **environmental conditions** before and during the operation (i.e. real-time evaluation) and the assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple record system. In the specific provisions for this scenario regarding training of remote flight crew, one of the included objectives as part of the minimum training of the remote pilot is to “understand how environmental conditions may affect the operation”.
	LEVEL of ASSURANCE		• Criterion #1 (Definition): The applicant declares that the required level of integrity has been achieved[(1)]. [(1)] *Supporting evidences may or may not be available*	• Criterion #1 (Definition): As “environmental conditions” are required to be included as part of the manufacturer’s documentation delivered with the UAS and supporting means, and this criterion for assurance is complied with.

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the scenario
			• Criterion #2 (Procedures): See “level of assurance” for Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)” • Criterion #3 (Training): see the “level of assurance” for Remote crew training (OSO #09, OSO #15 and OSO #22)”	• Criterion #2 (Procedures): see the “level of assurance” for Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)” • Criterion #3 (Training): see the “level of assurance” for Remote crew training (OSO #09, OSO #15 and OSO #22)”

Table B-1.8 – Compliance check of scenario proposed provisions against SORA criteria for OSOs (source: based on SORA V2.0)