JARUS-PDRA-05

PREDEFINED RISK ASSESMENT FOR AERIAL WORK OPERATIONS:

- **OVER SPARSELY POPULATED AREAS**
- **IN UNCONTROLLED AIRSPACE, WITH A LOW PROBABILITY OF ENCOUNTER WITH MANNED AIRCRAFT AND IN WHICH AT LEAST 50% MANNED AIRCRAFT ARE COOPERATIVE IN THE SENSE OF BEING DETECTABLE BY THE UAS OPERATOR**
- **BVLOS**
- **USING UNMANNED AIRCRAFT UP TO 3M DIMENSION**
- **WITHIN THE RANGE OF THE DIRECT C2 LINK**

DRAFT

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1. Overview of the PDRA

This PDRA was developed considering the increasing demand for UAS operations in BVLOS, in non-segregated airspace, without using airspace observers, with greater range and larger UAs compared to the operations currently covered by national regulations, and before U-space/UTM services supporting air traffic separation become widely available.

Therefore, this PDRA is intended to provide a means to facilitate the operational authorisation of such operations while still considering limitations that ensure a low intrinsic risk of the operations, including those identified in previous PDRAs for BVLOS operations:

- UA with maximum characteristic dimensions up to 3 m and typical kinetic energy up to 34 kJ;
- UA operated over sparsely populated areas;
- UA operated at very low level;
- BVLOS within the range of a direct C2 Link, which limits the area covered and also constitutes a conservative limitation considering the limited experience with communication networks (e.g. mobile networks);

The main provisions of the PDRA G-04 are:

- UA range limit: as in previous PDRAs for BVLOS operations, the launch/recovery should be conducted in VLOS distance from the remote pilot if not operating from a safe prepared area. As mentioned before, the range is limited in flight by the use of a direct C2 link, keeping operations within its coverage so that the safe conduct of the flight is ensured. As for PDRA G-03, the scope of the PDRA has been initially limited to the coverage of a direct C2 Link (direct link between the control station and the UA). Once more experience is gained with the use of those services, this PDRA might be revised to encompass their use with the introduction of the appropriate provisions;
- operational volume: same common provisions included in previous PDRAs;
- ground risk: in addition to common provisions included in previous PDRAs, technical provisions are proposed to assist the remote pilot in ensuring a low ground risk by providing real time information on the overflown area;
- air risk: in addition to the limitations previously mentioned, the particularity of this PDRA is that UAS operations are expected to be conducted in areas where the airspace can be classified as having low risk of encounter with manned aircraft (i.e. not more than ARC-b) and at least half of all potential airspace users in the vicinity can be detected by the UAS operator. In order to ensure that level of detection, the UAS operator should operate in areas where there is high confidence that at least half of the potential aircraft flying in the vicinity, uses equipment that allows the UAS operator to detect those aircraft with electronic means (e.g. ADS-B IN). Therefore, an airspace assessment is needed to determine the most suitable areas, and a guidance to the PDRA is provided for that purpose as appendix 1 to PDRA G-04. As also indicated in that guidance, the notification of intended operations to the identified airspace users is an important element to ensure a low risk of encounter. Besides, the UAS operator

should establish an air risk buffer if there is an adjacent airspace classified as ARC-d (the likelihood of an encounter with another aircraft in that airspace is high) or if the competent authority or the entity responsible for the airspace management considers necessary requiring it. Also, as an additional tactical mitigation to address the residual risk of conflicts with other airspace users in the vicinity, electronic and/or visual conspicuity methods acceptable to the competent authority may be used;

— UAS operator and operations provisions: same common provisions included in previous PDRAs;

— Technical provisions: in addition to the provisions included in other PDRAs, some specific provisions have been included in this PDRA, as mentioned above (means for information on the overflown area, means to detect cooperative traffic, electronic and/or visual conspicuity methods, etc.)

A risk assessment based on SORA is provided in '**Fejl! Henvisningskilde ikke fundet.**'.

2. PDRA characterisation and provisions

PDRA G-04 is the result of applying the SORA to UAS operations performed in the 'specific' category:

(1) with UA with maximum characteristic dimensions (e.g. wingspan, rotor diameter/area or maximum distance between rotors in case of multirotor) up to 3 m and typical kinetic energies up to 34 kJ;

(2) BVLOS of the remote pilot;

(3) over sparsely populated areas;

(4) within the range of the direct C2 Link in an operational volume under 150 m above the overflown surface (or any other altitude reference defined by the state of operations), and;

(5) in uncontrolled airspace, with a low probability of encounter with manned aircraft and in which at least 50% manned aircraft are cooperative in the sense of being detectable by the UAS operator.

PDRA characterisation and provisions	
1. **Operational characterisation (scope and limitations)**	
Level of human intervention	1.1 No autonomous operations: the remote pilot should have the ability to maintain control of the UA, except in the case of a lost command and control (C2) link. 1.2 The remote pilot should only operate one UA at a time. 1.3 The remote pilot should not operate from a moving vehicle. 1.4 The remote pilot should not hand over the control of the UA to another command unit.
UA range limit	1.5 <u>Launch/recovery</u>: VLOS distance from the remote pilot if not operating from a safe prepared area. *Note: a 'safe prepared area' means a controlled ground area that is suitable for the safe conduct of the launch/recovery of the UA.* 1.6 <u>In flight</u>: The range limit should be within the coverage of the direct C2 link that ensures the safe conduct of the flight.
Overflown areas	1.7 UAS operations should be conducted over sparsely populated areas.
UA limitations	1.8 Maximum characteristic dimension (e.g. wingspan, rotor diameter/area or maximum distance between rotors in the case of a multirotor): 3 m 1.9 Typical kinetic energy (as defined in paragraph 2.3.1(k) of SORA up to 34 kJ
Flight height limit	1.10 The maximum height of the operational volume should not be greater than 150 m above the overflown surface (or any other altitude reference defined by the state of operations) *Note: In addition to the vertical limit for the operational volume, an air risk buffer is to be considered (see 'air risk' under point 3 of this table).*
Airspace	1.11 The UA should be operated:

	1.12.1 in uncontrolled airspace (Class F or G) with a low risk of encounter with manned aircraft (corresponding to an air risk that can be classified as not higher than ARC-b); or 1.12.2 as otherwise established by the states (with an associated air risk that can be classified as not higher than ARC-b)
Visibility	1.12 If take-off and landing are conducted in VLOS of the remote pilot, visibility should be sufficient to ensure that no people are in danger during the take-off /landing phase. The remote pilot should abort the take-off or landing in case people on the ground are in danger.
Others	1.13 The UA should not be used to drop material or carry dangerous goods, except for dropping items in connection with agricultural, horticultural or forestry activities in which the carriage of the items does not contravene any other applicable regulations.

2. Operational risk classification (according to the classification defined in SORA)

Final GRC	**3**	Final ARC	**ARC-b**	SAIL	**II**

3. Operational mitigations

Operational volume	3.1 To determine the operational volume, the UAS operator should consider the position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time). 3.2 In particular, the accuracy of the navigation solution, the flight technical error of the UAS and the path definition error (e.g. map error) and latencies should be considered and addressed when determining the operational volume. 3.3 The remote pilot should apply the emergency procedures as soon as there is an indication that the UA may exceed the limits of the operational volume.
Ground risk	3.4 The UAS operator should establish a ground risk buffer to protect third parties on the ground outside the operational volume. 3.4.1 The minimum criterion should be the use of the '1:1 rule' (e.g. if the UA is planned to operate at a height of 100 m, the ground risk buffer should at least be 100 m). 3.5 The operational volume and the ground risk buffer should be all contained in a sparsely populated area. 3.6 The UAS operator should evaluate the area of operations typically by means of an on-site inspection or appraisal, and should be able to justify a lower density of people at risk. 3.7 The UAS operator should ensure that the person or entity responsible for the facility or infrastructure has taken the necessary measures to protect the uninvolved persons present within the limits of the facility or infrastructure during UAS operation *Note: Since the overflown area may not be a controlled ground area and its size may be significant, a real time surveillance means (e.g. camera) should be used to assist in ensuring a low ground risk during the operation (see point 6.3 under 'Technical provisions').* 3.8 The UAS operator should include points 3.4 to 3.7 in the Operations Manual (as required in point 4.1.1) and declare the compliance with those provisions.

Air risk	3.9 The UAS operation should be conducted in a subset of ARC-b airspace in which the UAS operator can substantiate the ability to detect at least 50 % of all aircraft within a distance of at least 3 NM from the operational volume, for the entirety of the operation. Appendix 3 to provides a methodology to make the airspace assessment. Based upon such airspace evaluation the competent authority may choose to designate airspaces meeting the above conditions in which case the operator is relieved from this evaluation. 3.10 Operations should meet the tactical mitigation DAA requirements with low robustness in accordance with section 2.4.4.2 of SORA, including the detection of approximately 50% of all aircraft in the detection volume for the entirety of the operation. 3.11 The UAS operator should establish an air risk buffer to protect third parties in the air outside the operational volume if: 3.10.1 the operational volume has an adjacent airspace classified as ARC-d; or 3.10.2 the competent authority, or the entity responsible for the airspace management, requires it to ensure the protection of third parties in the air. 3.12 The air risk buffer defined in point 3.11 should be contained in airspace class F or G (uncontrolled airspace) over sparsely populated areas or in UAS geographical zones defined by the state where the probability of encounter with manned aircraft and other airspace users is low. 3.13 The UAS operator should notify every operations to other airspace users by using a method designated or validated by the competent authority in a timely manner to give other airspace users sufficient notice of the intended operation(s). 3.14 The UAS operator should identify at least: 3.13.1 the format (e.g. NOTAM, email, service); 3.13.2 the content of the message (e.g. time, relevant airspace volume1, description, contact details of the UAS operator); 3.13.3 the period of notice 3.14 Air traffic services may be notified and thus they should inform manned aircraft in real time as needed.
Observers	N/A
4. Operator and UAS operations provisions	

[1] The relevant airspace volume may comprise the operational volume, air risk buffer (if applicable) and detection volume.

UAS operator & operations	4.1 The UAS operator should: 4.1.1 develop an Operations Manual (OM); 4.1.2 develop an emergency response plan (ERP) in accordance with the provisions for 'medium' level of robustness; 4.1.3 validate the operational procedures in accordance with the provisions for 'medium' level of robustness; 4.1.4 ensure the adequacy of the contingency and emergency procedures and prove them through any of the following: (a) dedicated flight tests; or (b) simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results; or (c) any other means acceptable to the competent authority; 4.1.5 have a policy that defines how the remote pilot and any other personnel in charge of duties essential to the UAS operation can declare themselves fit to operate before conducting any operation; 4.1.7 designate for each flight a remote pilot with adequate competency and other personnel in charge of duties essential to the UAS operation if needed. 4.1.8 ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference.
UAS maintenance	4.2 In addition to the responsibilities that are defined in the provisions for UAS operators in previous points of this PDRA, the UAS operator should: 4.2.1 The UAS maintenance instructions defined by the UAS operator should be included in the OM and cover at least the UAS manufacturer's instructions and requirements when applicable. 4.2.2 The maintenance staff should follow the UAS maintenance instructions when performing maintenance.
External services	4.3 The UAS operator should ensure that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. The UAS operator should declare that this level of performance is adequately achieved. 4.4 The UAS operator should define and allocate the roles and responsibilities between the UAS operator and the external service provider(s), if applicable.
5. Provisions for the personnel in charge of duties essential to the UAS operation	

	5.1 The UAS operator should ensure that all personnel in charge of duties essential to the UAS operation are provided with competency-based theoretical and practical training specific to their duties that consists of theoretical elements from Appendix 1 and practical elements from Appendix 2. In addition, the UAS operator should ensure the following. 5.2 The training programme should be documented (at least the training syllabus should be available). 5.3 Evidence of training should be presented for inspection upon request from the competent authority or authorised representative.
Remote pilot	5.4 The remote pilot has the authority to cancel or delay any or all flight operations under the following conditions: 5.4.1 the safety of persons is threatened; or 5.4.2 property on the ground is threatened; or 5.4.3 other airspace users are in jeopardy; or 5.4.4 there is a violation of the terms of this authorisation. 5.5 The remote pilot should ensure that the UA remains clear of clouds, and that the ability of the remote pilot to perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard is not hampered by clouds.
Multi-crew cooperation (MCC)	In applications where Multi-crew cooperation (MCC) might be required, the UAS operator should: 5.6 include procedures to ensure coordination between the remote crew members with robust and effective communication channels. Those procedures should cover as a minimum the: 5.6.1 assignment of tasks to the remote crew members; and 5.6.2 establishment of step-by-step communication; and 5.7 ensure that the training of the remote crew covers MCC.
Maintenance staff	5.8 Any staff member authorised by the UAS operator to perform maintenance activities should have been duly trained regarding the documented maintenance procedures. 5.9 Evidence of training should be presented for inspection upon request from the competent authority or authorised representative. 5.10 The UAS operator may declare that the maintenance team has received training regarding the documented maintenance procedures; however, evidence of this training should be made available upon request from the competent authority or authorised representative.

Personnel in charge of duties essential to the UAS operation is fit to operate	5.11 The UAS operator should have a policy defining how the personnel in charge of duties essential to the UAS operation can declare themselves fit to operate before conducting any operation. 5.12 The personnel in charge of duties essential to the UAS operation should declare that they are fit to operate before conducting any operation based on the policy defined by the UAS operator.
6. Technical provisions	
General	6.1 The UAS should be equipped with the means to monitor the critical parameters for a safe flight, in particular the: 6.1.1 UA position, height or altitude, ground speed or airspeed, attitude and trajectory; 6.1.2 UAS energy status (fuel, battery charge, etc.); and 6.1.3 status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS, etc.), means should be provided to monitor the adequate performance and trigger an alert if the level becomes too low. 6.2 The UA should have the performance capability to descend safely from its operating altitude to a 'safe altitude' in less than 1 minute. 6.3 The UAS should be equipped with means that provide the remote pilot with real time information on the overflown area to: 6.3.1 reduce the ground risk during an emergency landing; 6.3.2 avoid overflying areas with higher density of people if strategic data were not accurate; and 6.3.3 provide redundant information concerning the UA position and enhanced situational awareness to the remote pilot. 6.4 The means in point 6.3 should be compatible with the scope of visual conditions of targeted operation (e.g. night, if night operations are planned). *Note: This means could be, for example, a camera that may be part of the payload.*
Human–machine interface (HMI)	6.5 The UAS information and control interfaces should be clearly and succinctly presented and should not confuse, cause unreasonable fatigue, or contribute to causing any disturbance to the personnel in charge of duties essential to the UAS operation such that this could adversely affect the safety of the operation. 6.6 The UAS operator should conduct an UAS evaluation that considers and addresses human factors to determine whether the HMI is appropriate for the operation.

C2 links and communication	6.7 The UAS should comply with the applicable requirements for radio equipment and the use of the RF spectrum. 6.8 Protection mechanisms against interference should be used, especially if unlicensed bands (e.g. ISM) are used for the C2 Link (mechanisms such as such as FHSS, DSSS or OFDM technologies, or frequency de-confliction by procedure) 6.9 The UAS should be equipped with a C2 Link protected against unauthorised access to the command and control functions. 6.10 In case of a loss of C2 Link, the UAS should have a reliable and predictable method for the UA to recover the command and control link or terminate the flight in a way that reduces the effect on third parties in the air or on the ground; 6.11 In the event of an emergency, the remote pilot should have effective means to communicate with the relevant bodies.
Tactical mitigation	6.12 The UAS design should be adequate to ensure that the time required between a command given by the remote pilot and the UA executing it does not exceed 5 seconds. 6.13 Electronic means used to assist the remote pilot in being aware of UA position in relation to potential "airspace intruders" should provide the information with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. 6.14 The UAS should be equipped with means to detect cooperative aircrafts within at least 3 NM range from the UA, for instance ADS-B In (either on board the UA or at/in the command unit) *Note: These means should be able to detect at least 50% of all aircraft in the detection volume.* 6.15 The UAS should be equipped with green flashing light and covered with appropriate painting for purpose of enhancing visual conspicuity of the UA during day and night. *Note: the light is required to allow the detection and identification as a UA by manned aircraft flying very low and at relatively low speed* 6.16 Electronic and/or visual conspicuity methods acceptable to the competent authority may be used to reinforce the tactical mitigation of the air risk.
Containment	6.17 To ensure a safe recovery from a technical issue involving the UAS or an external system supporting the operation, the UAS operator should ensure that: 6.17.1 no probable failure of the UAS or any external system supporting the operation should lead to operation outside the operational volume. 6.17.2 it is reasonably expected that a fatality will not occur from any probable failure of the UAS, or any external system supporting the operation. *Note: 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.'* 6.18 A design and installation appraisal should be made available and should cover at least:

	6.18.1 the design and installation features (independence, separation and redundancy); 6.18.2 the particular risks (e.g. hail, ice, snow, electro-magnetic interference, etc.) relevant to the ConOps. 6.19 The following additional provisions should apply if the adjacent area includes an assembly of people or if the adjacent airspace is classified as ARC-c or ARC-d (in accordance with SORA): 6.19.1 The UAS should be designed to standards that are considered adequate by the competent authority and/or in accordance with a means of compliance that is acceptable to that authority such that: 6.19.1.1 the probability of the UA leaving the operational volume should be less than 10^{-4}/FH; and 6.19.1.2 no single failure of the UAS or of any external system supporting the operation should lead to operation outside the ground risk buffer *Note: The term 'failure' should to be understood as an occurrence, which affects the operation of a component, part, or element in such a way that it can no longer function as intended. Errors may cause failures but are not considered to be failures. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.* 6.19.2 SW and AEH whose development error(s) could directly lead to operations outside the ground risk buffer should be developed to an industry standard or methodology recognised as adequate by the competent authority. *Note 1: The proposed additional safety provisions cover both the integrity and assurance levels.* *Note 2: The proposed additional safety provisions do not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the competent authority. For instance, if the UA design includes an <u>independent</u> engine shutdown function which systematically prevents the UA from exiting the ground risk buffer due to single failures or a SW/AEH error of the flight controls, the intent of provisions 6.16.2 and 6.16.3 could be considered to be met.* *Note 3: For this PDRA, having adjacent airspace classified as ARC-c is also deemed subject to above additional requirements (in addition to ARC-d, as per SORA Step #9 (c))* 6.20 Compliance with the provisions in point 6.19.1 and 2 above should be substantiated by analysis and/or test data with supporting evidence.

67 ***Table PDRA-05.1 — Main limitations and provisions for PDRA-05***

Appendix 1 THEORETICAL KNOWLEDGE SUBJECTS FOR THE TRAINING OF THE REMOTE PILOT AND ALL THE PERSONNEL IN CHARGE OF DUTIES ESSENTIAL TO THE UAS OPERATION

(a) The ‘specific’ category (category B) may cover a wide range of UAS operations with different levels of risk. The UAS operator is therefore required to identify the competency required for the remote pilot according to the outcome of the risk assessment. This appendix 1 to PDRA-0504 covers the theoretical knowledge subjects while appendix 2 to PDRA-0504 covers the practical knowledge subjects applicable to all operations in the ‘specific’ category (category B).

(b) The UAS operator should propose to the competent authority, as part of the application, a theoretical knowledge training course for the remote pilot based on the elements defined for operations in the ‘open’ category (category A), complemented by the following elements. The UAS operator may use the same list of topics to propose also for the other personnel in charge of duties essential to the UAS operation, a theoretical knowledge training course with competency-based theoretical training specific to their duties.

(1) Air safety:

(i) remote pilot records;

(ii) logbooks and associated documentation;

(iii) good airmanship principles;

(iv) aeronautical decision-making;

(v) aviation safety;

(vi) air proximity reporting; and

(vii) advanced airmanship:

(A) manoeuvres and emergency procedures; and

(B) general information on unusual conditions (e.g. stalls, spins, vertical lift limitations, autorotation, vortex ring states);

(2) aviation regulations:

(i) introduction to the UAS regulation with focus on the ‘specific’ category (category B);

(ii) risk assessment, introduction to SORA; and

(iii) overview of PDRA;

(3) navigation:

(i) navigational aids and their limitations (e.g. GNSS)

(ii) reading maps and aeronautical charts (e.g. 1:500 000 and 1:250 000, interpretation, specialised charts, helicopter routes, U-space service areas, and understanding of basic terms); and

(iii) vertical navigation (e.g. reference altitudes and heights, altimetry);

(4) human performance limitations:

(i) perception (situational awareness in BVLOS operations); and

(ii) fatigue:

(A) flight durations within work hours;

(B) circadian rhythms;

(C) work stress; and

(D) commercial pressures;

(iii) attentiveness:

(A) eliminating distractions; and

(B) scan techniques;

(iv) medical fitness (health precautions, alcohol, drugs, medication etc.); and

(v) environmental factors such as vision changes from orientation to the sun;

(5) operational procedures:

(i) airspace classifications and operating principles;

(ii) U-Space/UTM;

(iii) procedures for airspace reservation;

(iv) aeronautical information publications;

(v) NOTAMs; and

(vi) mission planning, airspace considerations and site risk-assessment:

(A) measures to comply with the limitations and conditions applicable to the operational volume and the ground risk buffer for the intended operation; and

(B) BVLOS operations. Use of UA VOs;

(6) UAS general knowledge:

(i) loss of signal and system failure protocols — understanding the condition and planning for programmed responses such as returning to home, loiter, landing immediately;

(ii) flight termination systems; and

(iii) flight control modes;

(7) meteorology:

(i) obtaining and interpreting advanced weather information:

(A) weather reporting resources;

(B) reports;

(C) forecasts and meteorological conventions appropriate for typical UAS flight operations;

(D) local weather assessments;

(E) low-level charts; and

(F) METAR, SPECI, TAF;

(ii) regional weather effects — standard weather patterns in coastal, mountain or desert terrains; and

(iii) weather effects on the UA (wind, storms, mist, variation of wind with altitude, wind shear etc.); and

(8) technical and operational mitigations for air risks.

(i) principles of EVLOS by using airspace observers (AO);

(ii) principles of DAA.

(c) The UAS operator should provide competency-based theoretical training covering the emergency response plan (ERP) that includes the related proficiency requirements and recurrent training.

(d) The UAS operator may define additional aspects from the subjects mentioned in point (b) based on the UAS operations intended to be conducted:

(1) operational procedures;

(i) mission planning, airspace considerations and site risk-assessment — operations over a controlled ground area;

(ii) multi crew cooperation (MCC):

(A) coordination between the remote pilot and other personnel in charge of duties essential to the UAS operation (i.e. AO);

(B) crew resource management (CRM):

(a) effective leadership; and

(b) working with others;

(2) UAS general knowledge — the means supporting BVLOS operations:

(i) the means to monitor the UA (its position, height, speed, C2 Link, systems status, etc.);

(ii) the means of communication with VOs; and

(iii) the means to support air traffic awareness.

(3) Managing data sources regarding:

(i) Where to find the data

(ii) Security of the data

(iii) Quantity of the needed data

(iv) Impact on the storage of data

(e) The training and assessment should be appropriate to the level of automation of the operation

Appendix 2 PRACTICAL SKILL TRAINING OF THE REMOTE PILOT AND ALL THE PERSONNEL IN CHARGE OF DUTIES ESSENTIAL TO THE UAS OPERATION

(a) With regard to the practical skill training and assessment for the remote pilot, the UAS operator should consider the competency defined for the 'open' category (category A) complemented by the following. The UAS operator should adapt the practical skill training based on the characteristics of the operation and the functions available on board of the UAS. The UAS operator may use the same list of topic to propose also for the personnel in charge of duties essential to the UAS operation, other than remote pilot, a practical training.

(1) Preparation of the UAS operation:

(i) implement the necessary measures to comply with the limitations and conditions applicable to the operational volume and ground risk buffer for the intended operation in accordance with the operations manual procedures;

(ii) implement the necessary procedures to operate in controlled airspace, including a protocol to communicate with ATC and obtain clearance and instructions, if necessary;

(iii) confirm that all the necessary documents for the intended operation are on site; and

(iv) brief all participants about the planned operation.

(v) airspace scanning;

(vi) if airspace observers (AOs) are employed: adequate placement of AOs, and a deconfliction scheme that includes phraseology,

(2) Preparation for the flight:

(i) make sure that all the safety elements available on UAS, including the height and speed limitation systems, the flight termination system and its triggering system are operational;

(ii) Knowledge of the basic actions to be taken in the event of an emergency situation, including issues with the UAS, or if a mid-air collision hazard arises during the flight.

(3) Flight under abnormal conditions:

(i) manage a partial or complete power shortage of the unmanned aircraft propulsion system while ensuring the safety of third parties on the ground;

(ii) manage a situation of an incursion by a person not involved into the operational volume or the controlled ground area, and take appropriate measures to maintain safety;

(iii) react to, and take the appropriate corrective actions for a situations where the UA is likely to exceed the limit of the flight geography (contingency procedures) and from the operational volume (emergency procedures) as defined during the flight preparation;

(4) Emphasis should be placed on

(i) Normal, abnormal and emergency procedures;

(ii) Remote pilot incapacitation;

(iii) Skill test combined with periodic proficiency check;

(iv) Operating experience (with on the job training counting towards proficiency);

(v) Pre-flight, post-flight and documentation;

(vi) Recurrent training (UAS/FTD).

(b) The practical skill training may be conducted on the actual UAS or a flight training device (FTD). Emphasis should be placed on scenario based training (SBT) using highly structured scripts of real-world experiences for the specific operation to fortify learning in an operational environment and improving situation awareness. SBT should include realistic normal and emergencies scenarios that are written with specific learning objectives in mind.

(c) Practical skill training is checked during the assessment and can be done using the actual UAS or on a flight training device appropriate to the specific operation.

(d) Initial and recurring training:

(1) The UAS operator should ensure that specified minimum requirements with respect to time (e.g. programmed flying hours) for initial and recurrent training (e.g. duration and flying hours) are prescribed and provided in a manner that is acceptable and approved by the competent authority.

(2) Depending on the training course, each of the topics shown in Table 1 below may require an overview or in-depth training. In-depth training should be interactive and include discussions, case study reviews and role-plays, as deemed necessary to enhance learning.

Topic	Initial	Change of UAS	Change of Remote Pilot/crew	Recurrent Training
Situational awareness and error management		In-depth	Overview	
Company safety culture, operational			In Depth	

procedures, organisation	In Depth	Not Required		Overview
Stress management, fatigue and vigilance			Not Required	
Decision making		Overview		
Automation, philosophy of the use of automation	As Required	In-depth	In Depth	As Required
Specific UAS type-related differences			Not Required (same UAS type)	
Case based studies	In Depth		In Depth	As Required

Table 1 — Level of practical skill training in several topics depending on initial training, recurring training or change of UAS / UAS operator

Appendix 3: Rules for conducting an operational risk assessment

IDENTIFICATION OF AN ARC-B AIRSPACE WHERE APPROXIMATELY 50% OF ALL AIRCRAFT ARE DETECTED

1. Introduction

1.1. This document aims to provide guidance to UAS operators or competent authorities (called applicant from now on) to identify within an airspace classified ARC-b the subset where approximately 50% of all aircraft are detected. Based upon an airspace evaluation the competent authority may choose to designate areas portions of ARC-b airspace where approximately 50% of all aircraft are detected , in which case the operator is relieved from this evaluation.

1.2. 05 The UAS operator should be able to receive the signals emitted by cooperative manned aircraft and take action to remain well clear and avoid collisions. This scenario does not rely on radar or similar technology to detect non-cooperative manned aircraft. No credit is taken from the use of U-space/UTM or web based services for the detection requirement in this scenario but those may be used as additional mitigation means, if available.

2. Determination of ARC-b airspace where approximately 50% of all aircraft are detected

2.1. The applicant should:

2.1.1 determine those areas where the operation should not be authorised (risk reduction by airspace segregation). The applicant or competent authority should define minimum distances to any area with known other airspace activities that may preclude UAS operations in accordance with PDRA 04. This could include but is not limited to:

(a) controlled airspace;

(b) any known location used for take-off and landing of all types of aircraft operation (airports, helipads, ULM airfields, paraglider areas…)

(c) site of known UAS operations in the framework of model aircraft clubs and associations;

(d) area used for en-route operations below 150m (military routes, aerial work above linear infrastructure[2], etc.);

2.1.2 determine the other airspace users that might be present in the volume of the intended USA operation and in the airspace adjacent to it, and whether at least 50% of manned traffic can be expected to be cooperative. Moreover the applicant should determine the types of cooperative systems used. The determination may be done using the method defined in section 3 or any method accepted by the competent authority.

2.2. in order to reinforce a low probability of encounters (thus, reassuring an ARC-b airspace) and to potentially increase the ratio of cooperative aircraft the UAS operator is recommended to notify airspace users in advance on the intended UAS operation so that:

(a) airspace users potentially avoid the area,

(b) ATS provides traffic information when possible,

(c) pre flight coordination and/or information is enabled by contacting the USA operator,

(d) airspace users become cooperative (if possible).

2.3. Guidance on the implementation of notification is provided in section 4. If deconfliction is required following notification, the competent authority may establish a process to prioritise access to airspace. Furthermore, the competent authority should promote the notification system to maximise the number of informed non-cooperative aircraft operators.

3. Method for estimation of the other airspace users in the intended volume of operation and adjacent airspace, and whether they are cooperative

3.1. The following airspace users have to be taken into consideration (non exhaustive list): military aircraft, all helicopters including those operated for emergency and medical services (HEMS), flight training aircraft, gliders, paragliders, hang gliders, parachutes, specialised operations (aerial work), balloons, other general aviation, ultra-light aircraft, unmanned aircraft (including those operated in the framework of model aircraft clubs and associations)[3], etc.

[2] Operation could be authorised at the request of the entity responsible of the infrastructure

[3] Unmanned aircraft are included in the types of aircraft that should be taken into account even though the SORA does not address UAS on UAS collision risk in the air risk model. However if the UAS operations is performed in areas with high density of unmanned aircraft (e.g. area of model flying sites), this will pose an increased ground risk which is undesirable.

3.2. Step 1 Data gathering.

3.2.1 Gather the information needed on a national/regional basis from the competent authority and other relevant stakeholders. The analysis will provide an average percentage of manned aircraft being cooperative in VLL away from any exclusion area previously defined (refer to point 2.1.1) at national/regional level. This average may have a high degree of variation depending on the local conditions (e.g. gliders do not flight at night, balloons tend to operate in known weather and areas) and hence the analysis is unlikely to be applicable for the intended area of operation. Therefore, the next phase described in point 3.2.2 should be performed to adjust the analysis accordingly.

3.2.2 Gather and apply data applicable for the intended volume of operation taking into account all relevant local conditions. This will provide an adjustment to the local conditions of the intended area of operation.

If sufficient data is available to directly perform the analysis for the intended area of operation, points 3.2.1 and 3.2.2 can be accomplished in a single phase.

Step 1 can optionally be performed again in which limitations can be imposed in terms of time of the day or the year, weather conditions etc. to achieve a further reduction of non-cooperative traffic.

3.3 Step 2. Analysis

3.3.1 Determine all aircraft categories that might be present in the operational volume, in as much details as possible depending upon the data available. Some data will be available from the registry of the competent authority while other data may require engaging in the completion of a surveys with all airspace users (e.g contacts with national/regional organisations representing airspace users, etc.) Any data subject to judgement should be assessed conservatively to ensure the analysis rather overestimate the number of non-cooperative aircraft operating in the intended volume of operation.

3.3.2 For each aircraft category determine the following data:

3.3.2.1 category of aircraft in which they fall. If a category of aircraft is utilised for different type of operations in VLL ARC-b airspace, such a category should, if possible, be subdivided in categories for each type of operation. For example fixed wing GA aircraft used for crop dusting in VLL should be listed separately from other fix wing GA, since they spend a much higher percentage in VLL compared to the other GA aircraft operations;

3.3.2.2 number of aircraft;

3.3.2.3 yearly flight hours per aircraft;

3.3.2.4 Type of operation performed in VLL;

3.3.2.5 any information which can better define the typical areas where this aircraft category will operate (e.g. paragliders often operate from cliffs)

3.3.2.6 Any information that can define the areas where this aircraft category unlikely will operate (e.g. hot air balloons very seldom operate over the sea)

3.3.2.7 Percentage of the time in which this aircraft category operate in VLL away from any exclusion area previously defined (refer to point 3.2)

3.3.2.8 Percentage of aircraft having cooperative systems like ADS-B, FLARM (a cooperative system should not to be considered if the UAS operator cannot directly access to its signals)

3.3.2.9 Type of cooperative systems

3.3.3 For each aircraft category, the total number of yearly flights hours in VLL can be calculated as well as the number of yearly flight hours that are performed with a cooperative system.

3.3.4 Once all aircraft categories have been determined and values assigned, the total percentage of cooperative flight hours in VLL can also be calculated.

3.3.5 If needed, steps 1 and 2 are subsequently may be repeated for the intended area of operation including any further restrictions that may be imposed such as time of day, weather conditions etc.

3. Annex A: Risk assessment for PDRA-0505

The following risk assessment has been conducted by applying SORA to the PDRA-05.

3.1. Step #1 – CONOPS description

UAS operators that intend to perform a UAS operation under this PDRA should elaborate a concept of operations (ConOps) and describe it in the Operations Manual (see provision 4.1.1, which refers to the OM template, which includes the ConOps as one of the chapters). This ConOps needs to fit the operational limitations defined in this PDRA.

As part of the ConOps, the UAS operator should define the required operational volume and risk buffers (ground and air).

3.2. Step #2 — determination of the intrinsic 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 A1 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/BVLOS over controlled ground area	1	2	3	4
VLOS in sparsely populated environment	2	3	4	5
BVLOS in sparsely populated environment	3	4	5	6
VLOS in populated environment	4	5	6	8
BVLOS in populated environment	5	6	8	10
VLOS over gathering of people	7			
BVLOS over gathering of people	8			

Table A1 Determination of the intrinsic UAS Ground Risk Class (GRC)

From the limitations defining the proposed PDRA:

Operational scenarios: BVLOS over sparsely populated environment (over-flown areas uniformly inhabited with low density population)

UA characteristics:

- Up to 3m of characteristic dimension (e.g. wingspan or rotor diameter)
- Typical expected maximal kinetic energy of 34 kJ

Thus, the maximum Intrinsic UAS GRC is: **intrinsic GRC = 4**

3.3. Step #3 — final GRC determination

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

M1 – Strategic mitigations for ground risk with a “Low” level of robustness and, consequently:

Integrity:

— Criterion #1 (definition of the ground risk buffer)

As per point 3.4.1 of the PDRA, the UAS operator should define a ground risk buffer with at least a “1 to 1 rule”. For example, if the UA is planned to operate at a height of 120 m the ground risk buffer should be at least be a minimum of 120 m.

— Criterion #2 (evaluation of people at risk)

As per point 3.6 of the PDRA, the UAS operator should evaluate the area of operations typically by means of an on-site inspection or appraisal, and should be able to justify a lower density of people at risk.

Since the overflown area may not be a controlled ground area and its size may be significant, a provision has been included for a real time surveillance means (e.g. camera) to assist in ensuring a low ground risk during the operation (see provisions in points 6.3 and 6.4 of the PDRA)

Assurance:

The UAS operator should declare that the required level of integrity has been achieved for the above indicated integrity criteria. Supporting evidence may or may not be available.

M3 – An Emergency Response Plan (ERP) is in place, operator validated and effective with a “medium” level of robustness. As per point 4.1.2, the UAS operator should develop an ERP in accordance with the provisions for ‘medium’ level of robustness.

Consequently, as highlighted in Table A2, the **final GRC is 3**.

		Robustness			
Mitigation Sequence	**Mitigations for ground risk**	**Low / None**	**Medium**	**High**	**Correction**
1	M1 - Strategic mitigations for ground risk[4]	**0: None -1: Low**	**-2**	**-4**	**-1**
2	M2 - Effects of ground impact are reduced[5]	**0**	**-1**	**-2**	**0**

[4] This mitigation is meant as a means to reduce the number of people at risk.
[5] This mitigation is meant as a means to reduce the energy absorbed by the people of the ground upon impact.

3	M3 - An Emergency Response Plan (ERP) is in place, operator validated and effective	**1**	**0**	**-1**	**0**
Total correction					**-1**

Table A2 Mitigations for Final GRC determination (GRC)

3.4. Steps #4 to 6 — air risk assessment

3.4.1 Air risk classification and strategic mitigations

This PDRA covers UAS operations at very low level (< 150 m), in uncontrolled airspace (Class F or G) and over sparsely populated areas. Thus, according to Figure 4 (ARC assignment process) of SORA, the initial air risk classification is ARC-b. Besides, provision 1.10.1 indicates that the airspace should have associated a low risk of encounter with manned aircraft (corresponding to an air risk that can be classified as not higher than ARC-b). Alternatively, as indicated in point 1.10.2, the UAS should be operated as otherwise established by the state (with an associated air risk that can be classified as not higher than ARC-b).

Therefore, the **initial ARC is ARC-b**.

Furthermore, as indicated in point 3.8 of this PDRA, UAS operations under this PDRA as expected to be conducted in a subset of ARC-b airspace in which the UAS operator is able to comply with the SORA criterion for 'low' robustness of TMPR (see 'detect' criteria for ARC-b in Table D.2 — TMPR qualitative criteria table, in Annex D to SORA) consisting in the **detection of approximately 50% of all aircraft in the detection volume** for the entirety of the operation.

Although SORA indicates such criterion as tactical mitigation, this PDRA is conceived so that an strategic assessment is performed to select an area that complies with such criterion, that is, an area where the potential airspace users that occasionally may fly in the vicinity are, at least 50% of them, cooperative in the sense that can be detected by the UAS operator. This assessment may be performed by the UAS operator and accepted by the competent authority or the latter may designate the most appropriate areas meeting the airspace requirements of this PDRA in which case the operator is relieved from this assessment. A method for this assessment is provided in guidance to this PDRA (GM1 to SORA)

Since no strategic mitigation to decrease the initial ARC is included, the **final ARC remains as ARC-b**.

However, despite not considering any strategic mitigation to decrease the initial ARC, given that this PDRA addresses BVLOS operations in ARC-b with no tactical mitigation like airspace observers, it is believed that for this PDRA the assurance of a low risk of encounter consistent with ARC-b requires some **strategic measures** by the UAS operator, including:

the above mentioned airspace assessment to ensure at least 50% detection of cooperative traffics, and

a notification to other potential airspace users on the intended UAS operations, using an interface designated or accepted by the competent authority and with a notification timing defined or accepted also by this authority.

3.4.2 Tactical mitigation performance requirement (TMPR) and robustness levels

As indicated in Table A3 below, the TMPR and its robustness level are ‘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 A3: TMPR and TMPR Level of Robustness assignment

The proposed provisions for this PDRA 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 remote 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 operate.

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

TMPR using human “See and Avoid” schemas:

A VLOS limitation is included in this PDRA 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.

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

Regarding performance requirements for the “detect and avoid” functions, Table A4 shows TMPR for ARC-b (TMPR Low) and TMPR considered in proposed mitigations for the PDRA.

With regard to the range of the means to detect cooperative aircraft, the minimum value considered is 3 NM, in line with the one indicated in the “Feedback Loop” of Table A4 based on the following assumptions discussed in JARUS:

- With a hypothetical incoming aircraft at 120 knots (a typical cruising airspeed for a GA aircraft) crossing a 3NM threshold for tracking an intruder aircraft would provide 90 seconds *avoidance time*.
- Breakdown and total response time considered:

	Time (seconds)
Means to detect cooperative aircrafts: update rate[1]	5
Means to detect cooperative aircrafts: latency[1]	10

Remote pilot response[1]	5
UAS C2 link latency (RLOS, UA at 500 ft AGL)[2]	5
Time to descend to 60 ft from 500 ft AGL at 500 fpm[3]	53
TOTAL	*78*

[1] Values considered adequate by the subject matter experts consulted by JARUS for low TMPR.

[2] See value for the 'command' function in **Fejl! Henvisningskilde ikke fundet.**

[3] For example at 15 m above trees of 3 m (typically between 2 and 4 m): 18 m ~ 60 ft

Table A2-4: Breakdown and total response time considered for means to detect cooperative aircraft

Thus, typically for cooperative GA aircraft the 3NM detection rate is deemed sufficient even for low TMPR detection means with the above assumptions.

However, for cases like high-speed military aircraft flying low (e.g. fighter at 250 m/s / 485 kt) the maximum flight height for the UA should be significantly reduced to decrease the time of descent, in addition to other mitigations measures, as indicated in the guidance to this PDRA (Appendix 3).

Additionally, electronic and/or visual conspicuity methods acceptable to the competent authority may also be considered to reinforce the tactical mitigation of the air risk (point 6.16 of the PDRA).

3.5. Step #7 — final GRC determination

Considering that:

Ground risk: final GRC is 3.

Air risk: final ARC is ARC-b

Then, the resulting SAIL for this PDRA is **SAIL II**, as indicated in Table A5 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**

Table A5 SAIL determination

3.6. Step #8 — identification of Operational Safety Objectives (OSOs)

The purpose of this step is to evaluate the defences within the UAS operation in the form of OSOs and the associated level of robustness depending on SAIL. Table A6 provides a qualitative methodology to make this determination. In this table, 'O' means optional, 'L' means recommended with low robustness, 'M' means recommended with medium robustness, and 'H' means recommended with high robustness.

SAIL II corresponding to this PDRA is highlighted in yellow in Table A6 to show the required level of robustness for the different OSOs.

OSO Number (in line with SORA 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[6]	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

[6] 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 SORA Annex E)		SAIL					
		I	**II**	**III**	**IV**	**V**	**VI**
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

Table A6 Recommended operational safety objectives (OSOs)

3.4.3 Step #9 — adjacent area/airspace considerations

In the context of this PDRA following provisions derived from SORA apply, as indicated in the points 6.16 to 6.19 of this PDRA:

No probable failure of the UAS or any external system supporting the operation should lead to operation outside of the operational volume. Compliance with this should be substantiated by a design and installation appraisal and include ate least:

- design and installation features (independence, separation and redundancy);
- particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps.

The following additional provisions should apply if adjacent area/airspace are gathering of people or ARC-d:

- The probability of leaving the operational volume shall be less than 10-4/FH.
- No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer.

Compliance with the requirements above shall be substantiated by analysis and/or test data with supporting evidence.

- Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could directly lead to operations outside of the ground risk buffer shall be developed to an industry standard or methodology recognized as adequate by the competent authority.

3.7. 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 PDRA, under this step the compliance of proposed provisions for the PDRA against SORA criteria is performed as shown in:

For mitigations used to modify the intrinsic GRC: see Table A7 in point **Fejl! Henvisningskilde ikke fundet.** of this Annex.

For strategic mitigations for the initial ARC: Not applicable (see section 3.4.1)

For tactical mitigations for the final ARC: Table A8.

For operational safety objectives: see Table A9 in point **Fejl! Henvisningskilde ikke fundet.** of this Annex.

For adjacent area/airspace consideration: see Table A10 in point **Fejl! Henvisningskilde ikke fundet.** of this Annex.

3.8. Evaluation of mitigations means

3.8.1 Ground risk

Mitigations for the intrinsic GRC		Level of robustness	Criteria in SORA	Provisions for the PDRA
M3 - An Emergency Response Plan (ERP) is in place, operator validated and effective	LEVEL of INTEGRITY	Medium	An ERP should be defined by the applicant in the event of a loss of control of the operation. These are emergency situations where the operation could result in an unrecoverable state and in which: (a) the outcome of the situation highly relies on providence; or (b) could not be handled by a contingency procedure; or (c) when there is grave and imminent danger of fatalities The ERP proposed by an applicant is different from the emergency procedures. The ERP is expected to cover: (a) a plan to limit the escalating effect of an eminent crash (e.g. notify first responders), and (b) the conditions to alert ATM The ERP: (a) is suitable for the situation; (b) limits the escalating effects; (c) defines criteria to identify an emergency situation; (d) is practical to use; clearly delineates Remote Crew member(s) duties.	An ERP with medium levels of robustness is required

	LEVEL of ASSURANCE		Criterion #1 (Procedures) (a) The ERP is developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority. (b) The ERP is validated through a representative tabletop exercise consistent with the ERP training syllabus.	An ERP with medium levels of robustness is required
			Criterion #2 (Training) (a) Training syllabus is available (b) Competency-based theoretical and practical training is organised by the operator	An ERP with medium levels of robustness is required
M2 - Effects of UA impact dynamics are reduced (e.g. parachute)	LEVEL of INTEGRITY	None	N/A	N/A
	LEVEL of ASSURANCE		N/A	N/A
M1 - Technical containment in place and effective (e.g. Emergency Recovery Function)	LEVEL of INTEGRITY	Low	Criterion #1 (Definition of the ground risk buffer) The applicant defines a ground risk buffer with at least a 1 to 1 rule	Point 3.4 of the PDRA: *The UAS operator should establish a ground risk buffer to protect third parties on the ground outside the operational volume.* Point 3.4.1 of the PDRA: *The minimum criterion should be the use of the '1:1 rule' (e.g. if the UA is planned to operate at a height of 25 m, the ground risk buffer should at least be 25 m)'*
			Criterion #2 (Evaluation of people at risk)	Point 3.6 of the PDRA indicates that the UAS operator should evaluate the area of operations typically by

			The applicant evaluates the area of operations by means of on-site inspections/appraisals to justify lowering the density of people at risk (e.g. residential area during daytime when some people may not be present or an industrial area at night time for the same reason). There may be other examples.	means of an on-site inspection or appraisal, and should be able to justify a lower density of people at risk. Point 3.7 of the PDRA indicates that the UAS operator should ensure that the person or entity responsible for the facility or infrastructure has taken the necessary measures to protect the uninvolved persons present within the limits of the facility or infrastructure during UAS operation. In addition, a note after point 3.7 of the PDRA indicates that, since the overflown area may not be a controlled ground area and its size may be significant, a real time surveillance device (e.g. camera) should be used to as a 'tactical' ground risk mitigation to maintain the initial GRC. In points 6.3 and 6.4 of the PDRA provisions are included for the tactical means for ground risk mitigation.
	LEVEL of ASSURANCE		Criterion #1 (Definition of the ground risk buffer) The applicant declares that the required level of integrity has been achieved. Criterion #2 (Evaluation of people at risk) The applicant declares that the required level of integrity has been achieved. (Supporting evidence may or may not be available)	Point 3.8 of the PDRA indicates that the UAS operator should include points 3.4 to 3.7 in the Operations Manual and declare the compliance with those provisions.

Table A7 Compliance check of PDRA-05 provisions against SORA criteria for mitigations to the intrinsic GRC

3.8.2 Air risk

Tactical mitigations for the Final ARC		Level of robustness	Criteria in SORA (Annex D)	Provisions for the PDRA
	LEVEL of INTEGRITY	Low	Tactical mitigation performance requirements (TMPR) – 'Detect' function: – The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50 % of all aircraft in the detection volume. – This is the performance requirement in the absence of failures and defaults. – 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/Pilot Aware aircraft trackers Use of UTM/U-space Dynamic Geofencing Monitoring aeronautical radio communications (e.g. use of a scanner) TMPR – 'Decide' function: The UAS operator should have a documented deconfliction scheme, in which the UAS operator explains which tools or methods will be used for	TMPR – Detection: – Point 3.9 of the PDRA indicates that this PDRA is applicable to a subset of ARC-b airspace in which the UAS operator can substantiate meeting the provisions of this PDRA, including the capability of the UAS operator to detect approximately 50 % of all aircraft in the detection volume for the entirety of the operation. Based upon an airspace evaluation the competent authority may choose to designate areas meeting the airspace requirements of this PDRA in which case the operator is relieved from this evaluation. To determine the subset of ARC-b Very Low Level (VLL) airspaces in which the competent authority may authorise operations under this PDRA, an airspace assessment should be performed. Guidance to this assessment is provided in Appendix 3 to PDRA G-04. – Point 6.14 of the PDRA indicates that the The UAS should be equipped with means to detect cooperative aircrafts, for instance ADS-B In (either on board the UA or at/in the command unit) – As indicated in the above mentioned guidance, no credit is taken from the use of UTM or web-based services for the detection requirement in this PDRA

			detection and what the criteria are that will be applied for the decision to avoid incoming traffic. TMPR – 'Command' function: The UAS design must be adequate to ensure that the time required between a command given by the remote pilot and the UA executing it does not exceed 5 seconds. TMPR – 'Execute' function: UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute. TMPR – 'Feedback loop' function: 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.	but those may be used as additional mitigation means if available. TMPR – 'Decide': point 4.1.1 indicates that the UAS operator should develop an OM including a de-confliction scheme (i.e. the criteria that will be applied for the decision to avoid incoming traffic). TMPR – 'Command': point 6.12 of the PDRA indicates that the UAS design should be adequate to ensure that the time required between a command given by the remote pilot and the UA executing it does not exceed 5 seconds. TMPR – 'Execute': point 6.2 of the PDRA indicates that aircraft should have the performance capability to descend safely from its operating altitude to a 'safe altitude' in less than a minute. TMPR – 'Feedback loop': point 6.13 of PDRA indicates that means used to assist the remote pilot in being aware of UA position in relation to potential "airspace intruders" should provide the information with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. Besides, the figures indicated in the SORA criteria are considered as part of the determination of the minimum detection range, as described in section 3.4.2.

	LEVEL of ASSURANCE		The applicant declares that the required level of integrity has been achieved (Supporting evidences may or may not be available).	This information should be included in the Operations Manual.

Table A8 Compliance check of PDRA-05 provisions against SORA criteria for Tactical mitigations for the Final ARC

3.9. Operational Safety Objectives (OSOs)

Please note that OSOs that are considered as 'optional' for SAIL II are not been addressed in Table A9 below.

Operational Safety Objectives (OSOs)		**SAIL II level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the PDRA**
OSO #01 – Ensure the operator is competent and/or proven	LEVEL of INTEGRITY	Low	The applicant is knowledgeable of the UAS being used and as a minimum has the following relevant operational procedures: checklists, maintenance, training, responsibilities, and associated duties.	The UAS operator should establish procedures and limitations adapted to the type of the intended operation and the risk involved', which implies knowledge on the UAS intended to be used and relevant operational procedures. Furthermore, point 4.1.1 indicates that the UAS operator should develop an Operations Manual (OM).
	LEVEL of ASSURANCE		The elements requested for the level of integrity are addressed in the CONOPS.	Point 4.1.1 of the PDRA indicates that the UAS operator should develop an Operations Manual (OM)

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
OSO #03 – UAS maintained by competent and/or proven entity (e.g. industry standards)	LEVEL of INTEGRITY	Low	The UAS maintenance instructions are defined and when applicable cover the UAS designer instructions and requirements. when applicable. The maintenance staff is competent and has received an authorisation to carry out UAS maintenance. The maintenance staff use the UAS maintenance instructions while performing maintenance.	The UAS operator should maintain the UAS in a suitable condition for safe operation by, as a minimum, defining maintenance instructions and employing an adequately trained and qualified maintenance staff. Besides, point 4.2 of the PDRA indicates that UAS maintenance instructions defined by the UAS operator should cover at least the UAS manufacturer's instructions and requirements when applicable. Point 4.2 of the PDRA indicates that the maintenance staff should use the UAS maintenance instructions while performing maintenance.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	LEVEL of ASSURANCE		Criterion #1 (Procedure): – The maintenance instructions are documented. – The maintenance conducted on the UAS is recorded in a maintenance log system[1/2]. – A list of maintenance staff authorised to carry out maintenance is established and kept up to date. [1] Objective is to record all the maintenance performed on the aircraft, and why it is performed (defects or malfunctions rectification, modification, scheduled maintenance etc.) [2] The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative. Criterion #2 (Training): A record of all relevant qualifications, experience and/or trainings completed by the maintenance staff is established and kept up to date.	Criterion#1: – Point 4.2 of the PDRA indicates that UAS maintenance instructions defined by the UAS operator should be included in the OM together with the maintenance instructions required to keep the UAS in safe condition. – the UAS operator should keep an up-to-date record of the maintenance activities conducted on the UAS for a minimum of 3 years. – the UAS operator should establish and keep an up-to-date list of the maintenance staff employed by the operator to carry out maintenance activities. Criterion #2: the UAS operator should keep and maintain an up-to-date record of all the relevant qualifications training courses completed by the maintenance staff, for at least 3 years after those persons have ceased employment with the organisation or have changed their position in the organisation.

OSO #06 – C3 link performance is appropriate for the operation	LEVEL of INTEGRITY	Low	The applicant determines that performance, RF spectrum usage[1] and environmental conditions for C3 links are adequate to safely conduct the intended operation. The UAS remote pilot has the means to continuously monitor the C3 performance and ensure the performance continues to meet the operational requirements[2]. *[1] For a low level of integrity, unlicensed frequency bands might be acceptable 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), by showing the UAS equipment is compliant with these requirements (e.g. FCC marking), and – the use of mechanisms to protect against interference (e.g. FHSS, frequency deconfliction by procedure). *[2] The remote pilot has continual and timely access to the relevant C3 information that could effect the safety of flight. For operations with a low level of integrity for this OSO, this could be achieved by monitoring the C2 link signal*	the UAS operator should ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference. Besides: – the remote pilot should 'ensure that the operating environment is compatible with the authorised or declared limitations and conditions' – Point 6.7 of the PDRA indicates The UAS should comply with the appropriate requirements for radio equipment and the use of the RF spectrum. – Point 6.8 of the PDRA indicates that protection mechanisms against interference should be used, especially if unlicensed bands (e.g. ISM) are used for the C2 Link (mechanisms such as such as FHSS, DSSS or OFDM technologies, or frequency de-confliction by procedure) Point 6.1 of the PDRA indicates that means to monitor critical parameters for a safe flight should be available, and point 6.1.3 includes status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS, etc.) Point 6.10 of the PDRA indicates that in case of a loss of C2 Link, the UAS should have a reliable and predictable method for the UA to recover the command and control

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
			strength and receiving an alert from the UAS HMI if the signal becomes too low.	link or terminate the flight in a way that reduces the effect on third parties in the air or on the ground. Point 6.11 of the PDRA indicates that In the event of an emergency, the remote pilot should have effective means to communicate with the relevant bodies.
	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.*	This information should be included in the Operations Manual.
OSO #07 Inspection of the UAS (product inspection) to ensure consistency to the ConOps	LEVEL of INTEGRITY	Low	The remote crew ensures that the UAS is in a condition for safe operation and conforms to the approved ConOps.	the remote pilot should 'ensure that the UAS is in a safe condition to complete the intended flight safely'. Pre-flight inspection is included in the Operations Manual

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	LEVEL of ASSURANCE		Criterion #1 (Procedure): – Product inspection is documented and accounts for the manufacturer's recommendations if available. Criterion #2 (Training): The remote crew is trained to perform the product inspection, and that training is self-declared (with evidence available).	Criterion #1: The verification that the UAS is in safe condition for the intended operation is included as one of the aspects to be documented in the OM Criterion #2: – the UAS operator should ensurethat remote pilots 'have been informed about the UAS operator's operations manual' and that personnel in charge of duties essential to the UAS operation, other than the remote pilots, 'have completed the on-the-job-training developed by the operator, and have been informed about the UAS operator's operations manual'. – the training programme should be documented (at least the training syllabus should be available).

Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)	LEVEL of INTEGRITY	Medium	Criterion #1 (Procedure definition): – Operational procedures1 appropriate for the proposed operation are defined and as a minimum cover the following elements: Flight planning, Pre and post-flight inspections, Normal procedures, Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation), Procedures to cope with unintended adverse operating conditions (e.g. when ice is encountered during an operation not approved for icing conditions) Contingency procedures (to cope with abnormal situations), Emergency procedures (to cope with emergency situations), and Occurrence reporting procedures. – Normal, Abnormal, and Emergency procedures are compiled in an Operation Manual.	Criterion #1: – the UAS operator should 'establish procedures and limitations adapted to the type of the intended operation and the risk involved, including operational procedures to ensure the safety of the operations'. – Point 4.1.1 of the PDRA indicates that the UAS operator should develop an Operations Manual (OM) which should include all the elements indicated in SORA criterion #1. Criterion #2: – The UAS operator should reduce the level of complexity avoiding raising the workload and/or the interactions with other entities (e.g. ATM, etc.) of remote pilots and/or other personnel in charge of duties essential to the UAS operation to a level that may jeopardise their ability to perform adequately the procedures. Since taking manual control is still under JARUS discussion, it has not been considered in the assessment.Criterion #3: – Operational procedures should be developed to minimise human errors. To that aim it is important that:

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
			– The limitations of the external systems used to support UAS 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 control1 when the UAS is usually automatically controlled. Criterion #3 (Consideration of Potential Human Error): Operational procedures take considerations of human errors. At a minimum, Operational procedures provide: – a clear distribution and assignment of tasks – an internal checklist to ensure staff are performing their assigned tasks.	– each of the tasks and the complete sequence of tasks of a procedure are clearly defined, designing them to be intuitive and unambiguous; – tasks are clearly distributed and assigned to the relevant roles and persons, ensuring a balanced workload; — procedures address adequately fatigue and stress, considering among other aspects: duty times, regular breaks, rest periods, the applicable health and safety requirements on the operational environment, handover/takeover procedures, responsibilities and workload..

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	LEVEL of ASSURANCE		– Operational procedures are validated against recognized standards. – The adequacy of the Contingency and Emergency procedures are proved through: – Dedicated flight tests, or – Simulation provided the simulation is proven valid for the intended purpose with positive results.	Point 4.1.3 of the PDRA indicates that the UAS operator should validate the operational procedures in accordance with the provisions for 'medium' level of robustness; Point 4.1.4 of the PDRA indicates that the UAS operator should ensure the adequacy of the contingency and emergency procedures and prove it through any of the following: (a) dedicated flight tests; or (b) simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results; or (c) any other means acceptable to the competent authority.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
Remote crew training (OSO #09, OSO #15 and OSO #22)	LEVEL of INTEGRITY	Low	The competency-based theoretical and practical training ensures knowledge of: a) UAS regulation b) UAS airspace operating principles c) Airmanship and aviation safety d) Human performance limitations e) Meteorology f) Navigation/Charts g) UA knowledge h) Operating procedures and is adequate for the operation.	Appendices 1 and 2 lists the competencies required for remote pilots operating UAS in the 'specific' category. the UAS operator should ensure before conducting operations that the remote pilot has the appropriate competency. the remote pilot should have the appropriate remote pilot competency.
	LEVEL of ASSURANCE		Training is self-declared (with evidence available)	The remote pilot should carry a proof of competency while operating the UAS. – the training programme should be documented (at least the training syllabus should be available); and – evidence of training should be presented for inspection upon request from the competent authority or authorised representative.

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	The objective of these OSOs is to complement the technical containment safety requirements by addressing the risk of a fatality occurring while operating over populous areas or gatherings of people. External systems supporting the operation are defined as systems not already part of the UAS but used to: launch / take-off the UAS, make pre-flight checks, keep the UA within its operational volume (e.g. GNSS, Satellite Systems, Air Traffic Management, UTM). External systems activated/used after the loss of control of the operation are excluded from this definition. It is expected when operating over populous areas or gatherings of people, a fatality will not occur from any probable[1] failure[2] 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.	N/A as operations are planned in sparsely populated areas

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	LEVEL of ASSURANCE		A design and installation appraisal is available. In particular, this appraisal shows that: the design and installation features (independence, separation and redundancy) satisfy the low integrity criterion; particular risks relevant to the ConOps (e.g. hail, ice, snow, electro-magnetic interference…) do not violate the independence claims, if any.	N/A as operations are planned in sparsely populated areas
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.	Point 4.3 of the PDRA indicates that the UAS operator should ensure that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. The UAS operator should declare that this adequate level of performance is achieved. Point 4.4 of the PDRA indicates that the UAS operator should define the allocation of the roles and responsibilities between the operator and the external service provider(s), if applicable.
	LEVEL of ASSURANCE		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)	This information should be included in the Operations Manual.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
OSO #16 Multi crew coordination	LEVEL of INTEGRITY	Low	Criterion #1 (Procedures): – Procedure(s) to ensure coordination between the crew members and that robust and effective communication channels is (are) available and at a minimum cover: assignment of tasks to the crew, establishment of step-by-step communications. Criterion #2 (Training): Remote Crew training covers multi crew coordination.	Criterion #1: According to point 5.6 of the PDRA, in applications where multi-crew cooperation (MCC) might be required, the UAS operator should include procedures to ensure coordination between the remote crew members with robust and effective communication channels. Those procedures should cover as a minimum: – the assignment of tasks to the remote crew members; and – the establishment of step-by-step communication; and Criterion #2: According to point 5.6 of the PDRA, in applications where MCC might be required, the UAS operator should ensure that the training of the remote crew covers MCC.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	LEVEL of ASSURANCE		Criterion #1 (Procedures): – Procedures are not required to be validated against a recognized standard. – The adequacy of the procedures and checklists is declarative. Criterion #2 (Training): – Training is self-declared (with evidence available)	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.	Point 4.1.5 of the PDRA indicates that the UAS operator should have a policy that defines how the remote pilot and any other personnel in charge of duties essential to the UAS operation can declare themselves 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.	The remote crew shall declare that they are fit to operate before conducting any operation 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.	Point 6.5 of the PDRA indicates that the UAS information and control interfaces should be clearly and succinctly presented and should not confuse, cause unreasonable fatigue, or contribute to causing any disturbance to the personnel in charge of duties essential to the UAS operation such that this could adversely affect the safety of the operation.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	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.	Point 6.6 of the PDRA indicates that the UAS operator should conduct an evaluation of the UAS considering and addressing human factors to determine whether the HMI is appropriate for the mission.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
OSO #23 Environmental conditions for safe operations defined, measurable and adhered to	LEVEL of INTEGRITY	Low	Criterion #1 (Definition) Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document. Criterion #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. Criterion #3 (Training): Training covers assessment of meteorological conditions.	Criterion #1: the OM should include a paragraph on the operational environment and geographical area for the intended operations (in general terms, describe the characteristics of the area to be overflown, its topography, obstacles etc., and the characteristics of the airspace to be used, and the environmental conditions (i.e. the weather and electromagnetic environment); the definition of the required operation volume and risk buffers to address the ground and air risks). Criterion #2: the OM should contain a point on environmental and weather conditions, including: – environmental and weather conditions adequate to conduct the UAS operation; and – methods of obtaining weather forecasts Criterion #3: According to Appendix 1 to this PDRA 'meteorology' as one of the basic competencies from the competency framework that are necessary.

Operational Safety Objectives (OSOs)		SAIL II level of robustness	Criteria in SORA for SAIL II	Provisions for the PDRA
	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 #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 #1 (Definition): This information should be included in the Operations Manual. 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 A9 Compliance check of PDRA-05 provisions against SORA criteria for Operational Safety Objectives (OSOs)

3.10. Adjacent area/airspace consideration

Mitigations used for containment		Level of robustness	Criteria in SORA	Provisions for the PDRA
	LEVEL of INTEGRITY	Medium	No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.	Point 6.10 of the PDRA indicates that ensure a safe recovery from a technical issue involving the UAS or an external system supporting the operation, the UAS operator should ensure: that no probable failure of the UAS or any external system supporting the operation should lead to operation outside the operational volume, and that it is reasonably expected that a fatality will not occur from any probable failure of the UAS, or any external system supporting the operation.
	LEVEL of ASSURANCE		Compliance with the requirement above shall be substantiated by a design and installation appraisal and shall include at least: design and installation features (independence, separation and redundancy); particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps.	Point 6.18 of the PDRA indicates that a design and installation appraisal should be made available and include at least: design and installation features (independence, separation and redundancy); particular risks (e.g. hail, ice, snow, electro-magnetic interference, etc.) relevant to the ConOps.

Mitigations used for containment		Level of robustness	Criteria in SORA	Provisions for the PDRA
	LEVEL of INTEGRITY		Following additional requirements shall apply if adjacent area/airspace are gathering of people or ARC-d: The probability of leaving the operational volume shall be less than 10-4/FH. No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer.	Point 6.17 of the PDRA indicates that the following additional provisions should apply if the adjacent area includes an assembly of people or if the adjacent airspace is classified as ARC-d (in accordance with SORA): – The probability of leaving the operational volume shall be less than 10-4/FH. – No single failure of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer.
	LEVEL of ASSURANCE		Compliance with the requirements above should be substantiated by analysis and/or test data with supporting evidence.	Point 6.18 of the PDRA indicates that compliance with the provisions in point 6.17 (see above) should be substantiated by analysis and/or test data with supporting evidence.

Mitigations used for containment		Level of robustness	Criteria in SORA	Provisions for the PDRA
	LEVEL of INTEGRITY		Software (SW) and airborne electronic hardware (AEH) whose development error(s) could directly[1] lead to operations outside the ground risk buffer should be developed to an industry standard or methodology that is recognised as being adequate by the competent authority. [2]*This does not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the competent authority. The use of the term 'directly' means that a development error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for another system to prevent the UA from exiting the operational volume.*	Point 6.19.3 of the PDRA indicates that the SW and AEH whose development error(s) could directly lead to operations outside the ground risk buffer should be developed to an industry standard or methodology recognised as adequate by the competent authority (the same note in SORA for 'directly' is also included in this provision).
	LEVEL of ASSURANCE		[*Not explicitly indicated in SORA*] Evidence exist of compliance with an industry standard or methodology that is recognised as being adequate by the competent authority.	Evidence of compliance standard(s) or means of compliance considered adequate by the competent authority.

Table A10 Compliance check of PDRA-05 provisions against SORA criteria for mitigations used for containment