Specific Operations Risk Assessment

Application for BVLOS flight by SDU UAS Center

SDU UAS Center 2018

# 1. Introduction

This document contains a Specific Operations Risk Assessment (SORA) and associated documentation to be presented to the Danish Civil Aviation Authority (CAA) Trafikstyrelsen (TBST).

The content of this document is based on the draft JARUS guidelines on Specific Operations Risk Assessment (SORA) for external consultation, Edition 1.2 dtd 31.05.2018.

# 2. Concept of Operation

This Concept of Operation (ConOps) describes operation of a….

The UAS will be operated and piloted by the SDU UAS Center, HCA Airport (EKOD) in Odense, Denmark. Specifically, the operation area is within the restricted air spaces EK R OD1 respecting a 2.5 NM horizontal separation as defined in Appendix B (and map figure B.1).

# 3. Technical information

# 4. The SORA process

## 4.1 Pre-application evaluation

## 4.2 Step #1 – ConOps description

The ConOps is documented in section 2.

The technical information is documented in section 3.

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

## 4.4 Step #3 – Final GRC determination

## 4.5 Step #4 – Determination of the Initial Air-Risk Class (ARC)

## 4.6 Step #5 – Application of Strategic Mitigations

## 4.7 Step #6 – Adjacent Airspace Considerations

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

## 4.9 Step #8 – SAIL determination

## 4.10 Step #9 - Identification of Operational Safety Objectives (OSO)

### Technical issue with the UAS

#### OSO#01 Ensure the operator is competent and/or proven

*[SAIL II: Low robustness*

*What: The applicant has knowledge of the UAS being used and has relevant*

*operational procedures including at least: checklists, maintenance, training,*

*responsibilities, and duties.*

*Prove: The elements requested for the level of integrity are addressed in the CONOPS. ]*

#### OSO#03 UAS maintained by competent and/or proven entity

*[SAIL II: Low robustness*

*What: The UAS maintenance procedures are defined and cover at least the UAS designer instructions and requirements.*

*The maintenance team (i.e. the personnel authorized to conduct maintenance on the UAS in line with the maintenance procedures) is defined.*

*Prove: The maintenance procedures are documented. The maintenance conducted on the*

*UAS are document in a maintenance log ]*

OSO#06 C3 link performance is appropriate for the operation

*[SAIL II: Low robustness*

*What:The applicant determines that performance, RF spectrum usage (1)(2) and environmental conditions for C3 links are adequate to conduct safely the intended operation.*

*The UAS remote pilot has the means to continuously monitor the performance of C3 to ensure the adequacy of that performance to the operation requirements*

*Prove: Refer to the criteria provided in section 9.]*

#### OSO#07 Inspection of the UAS (product inspection) to ensure consistency to the ConOps

*[SAIL II: Low robustness*

*What: The remote crew performs pre-flight inspection to ensure the UAS is in a condition for safe operation and conforms to the approved concept of operations.*

*Prove: Pre-flight inspection procedure is documented.]*

### Operational procedures

#### OSO#08 Operational procedures are defined, validated and adhered to

*[SAIL II: Medium robustness (Here information from Annex E for Medium is inserted)*

*What: (Also for OSO#11, #14, #21) Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements:*

* *Flight planning,*
* *Pre and post-flight inspections,*
* *Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),*
* *Procedures to cope with adverse operating conditions (e.g. what to do in case icing is encountered during the operation, when the operation is not approved for icing conditions)*
* *Normal procedures,*
* *Contingency procedures (to cope with abnormal situations),*
* *Emergency procedures (to cope with emergency situations), and*
* *Occurrence reporting procedures.*

*Normal, Abnormal and Emergency procedures are compiled in an Operation Manual.*

*The limitations of the external systems supporting UAS for safe operations are defined in an Operation Manual.*

*Operational procedures involve the remote pilot to take manual control 1*

*when the UAS is usually automatically controlled.*

*Operational procedures take considerations of human errors.*

*Prove: Operational procedures are validated against recognized standards.*

*The adequacy of the Abnormal and Emergency procedures is proved through:*

* *Dedicated flight tests, or*
* *Simulation, provided that the representativeness of the simulation means is*

*proven for the intended purpose with positive results.]*

#### OSO#11 Procedures are in-place to handle the deterioration of external systems supporting UAS operation

*[SAIL II: Medium robustness*

*What: (Also for OSO#08, #14, #21) Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements:*

* *Flight planning,*
* *Pre and post-flight inspections,*
* *Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),*
* *Procedures to cope with adverse operating conditions (e.g. what to do in case icing is encountered during the operation, when the operation is not approved for icing conditions)*
* *Normal procedures,*
* *Contingency procedures (to cope with abnormal situations),*
* *Emergency procedures (to cope with emergency situations), and*
* *Occurrence reporting procedures.*

*Normal, Abnormal and Emergency procedures are compiled in an Operation Manual.*

*The limitations of the external systems supporting UAS for safe operations are defined in an Operation Manual.*

*Operational procedures involve the remote pilot to take manual control when the UAS is usually automatically controlled.*

*Operational procedures take considerations of human errors.*

*Prove: Operational procedures are validated against recognized standards.*

*The adequacy of the Abnormal and Emergency procedures is proved through:*

* *Dedicated flight tests, or*
* *Simulation, provided that the representativeness of the simulation means is*

*proven for the intended purpose with positive results.]*

#### OSO#21 Operational procedures are defined, validated and adhered to

*[SAIL II: Medium robustness*

*What: (Also for OSO#11, #14, #21) Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements:*

* *Flight planning,*
* *Pre and post-flight inspections,*
* *Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),*
* *Procedures to cope with adverse operating conditions (e.g. what to do in case icing is encountered during the operation, when the operation is not approved for icing conditions)*
* *Normal procedures,*
* *Contingency procedures (to cope with abnormal situations),*
* *Emergency procedures (to cope with emergency situations), and*
* *Occurrence reporting procedures.*

*Normal, Abnormal and Emergency procedures are compiled in an Operation Manual.*

*The limitations of the external systems supporting UAS for safe operations are defined in an Operation Manual.*

*Operational procedures involve the remote pilot to take manual control 1*

*when the UAS is usually automatically controlled.*

*Operational procedures take considerations of human errors.*

*Prove: Operational procedures are validated against recognized standards.*

*The adequacy of the Abnormal and Emergency procedures is proved through:*

* *Dedicated flight tests, or*
* *Simulation, provided that the representativeness of the simulation means is*

*proven for the intended purpose with positive results.]*

### Remote crew training

OSO#09 Remote crew trained and current and able to control the abnormal situation

*[SAIL II: Low robustness*

*What: (Also for OSO#15, #22) The competency-based theoretical and practical training should consist of the following elements:*

*Basic competencies from the competency framework necessary to ensure a safe flight:*

1. *Application of operational procedures (normal, contingency and emergency procedures, flight planning, pre-flight and post-flight inspections…)*
2. *Communication*
3. *RPA flight path management, automation*
4. *Leadership, teamwork and self-management*
5. *Problem solving and decision-making*
6. *Situational awareness*
7. *Workload management*
8. *Coordination and handover*

*Familiarization with CAT B (Specific Category)*

*A rating training specific for the operation.*

*Prove: Training is self-declared (with evidence available)]*

#### OSO#15 Remote crew trained and current and able to control the abnormal situation

*[SAIL II: Low robustness*

*What: (Also for OSO#15, #22) The competency-based theoretical and practical training should consist of the following elements:*

*Basic competencies from the competency framework necessary to ensure a safe flight:*

1. *Application of operational procedures (normal, contingency and emergency procedures, flight planning, pre-flight and post-flight inspections…)*
2. *Communication*
3. *RPA flight path management, automation*
4. *Leadership, teamwork and self-management*
5. *Problem solving and decision-making*
6. *Situational awareness*
7. *Workload management*
8. *Coordination and handover*

*Familiarization with CAT B (Specific Category)*

*A rating training specific for the operation.*

*Prove: Training is self-declared (with evidence available)]*

#### OSO#22 The remote crew is trained to identify critical environmental conditions and to avoid them

*[SAIL II: Low robustness*

*What: (Also for OSO#15, #22) The competency-based theoretical and practical training should consist of the following elements:*

*Basic competencies from the competency framework necessary to ensure a safe flight:*

1. *Application of operational procedures (normal, contingency and emergency procedures, flight planning, pre-flight and post-flight inspections…)*
2. *Communication*
3. *RPA flight path management, automation*
4. *Leadership, teamwork and self-management*
5. *Problem solving and decision-making*
6. *Situational awareness*
7. *Workload management*
8. *Coordination and handover*

*Familiarization with CAT B (Specific Category)*

*A rating training specific for the operation.*

*Prove: Training is self-declared (with evidence available)]*

### Safe design

#### OSO#10 Safe recovery from technical issue

*[SAIL II: Low robustness*

*What: (Also for OSO#12) No probable failure of the UAS or any external system supporting the operation leads to operation outside of the operation volume*

*It can be reasonably expected that a fatality will not occur from any probable failure of the UAS or any external system supporting the operation.*

*Prove: A design and installation appraisal is available. In particular, the design and installation features (independence, separation and redundancy) allowing to meet the low integrity criteria are explained.]*

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#### OSO#12 The UAS is designed to manage the deterioration of external systems supporting UAS operation

*[SAIL II: Low robustness*

*What: No probable failure of the UAS or any external system supporting the operation leads to operation outside of the operation volume*

*It can be reasonably expected that a fatality will not occur from any probable failure of the UAS or any external system supporting the operation.*

*Prove: A design and installation appraisal is available. In particular, the design and installation features (independence, separation and redundancy) allowing to meet the low integrity criteria are explained.]*

### Deterioration of external systems supporting the UAS operation

#### OSO#13 External services supporting UAS operations are adequate to the operation

*[SAIL II: Low robustness*

*What: 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.*

*Prove: 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).]*

### Human error

#### OSO#14 Operational procedures are defined, validated and adhered to

*[SAIL II: Medium robustness*

*What: (Also for OSO#08, #11, #21) Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements:*

* *Flight planning,*
* *Pre and post-flight inspections,*
* *Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),*
* *Procedures to cope with adverse operating conditions (e.g. what to do in case icing is encountered during the operation, when the operation is not approved for icing conditions)*
* *Normal procedures,*
* *Contingency procedures (to cope with abnormal situations),*
* *Emergency procedures (to cope with emergency situations), and*
* *Occurrence reporting procedures.*

*Normal, Abnormal and Emergency procedures are compiled in an Operation Manual.*

*The limitations of the external systems supporting UAS for safe operations are defined in an Operation Manual.*

*Operational procedures involve the remote pilot to take manual control when the UAS is usually automatically controlled.*

*Operational procedures take considerations of human errors.*

*Prove: Operational procedures are validated against recognized standards.*

*The adequacy of the Abnormal and Emergency procedures is proved through:*

* *Dedicated flight tests, or*
* *Simulation, provided that the representativeness of the simulation means is*

*proven for the intended purpose with positive results.]*

#### OSO#16 Multi crew coordination

*[SAIL II: Low robustness*

*What: Procedure(s) to ensure a coordination between the crew members with robust and effective communication channels is (are) available and covers at minimum:*

* *assignment of tasks to the crew,*
* *establishment of a step-by-step communication.*

*Remote Crew training covers multi crew coordination*

*Prove: Procedures are not required to be validated against a recognized*

*standard. The adequacy of the procedures and checklists is declarative.*

*Training is self-declared (with evidence available)*

*The level of assurance associated to this criterion needs to be assessed considering a technical OSO nature (refer to section 9)]*

OSO#17 Remote crew is fit to operate

*[SAIL II: Low robustness*

*What: The applicant has a policy defining how the remote crew can declare*

*themselves fit to operate before conducting any operation.*

*Prove: The remote crew declare they are fit to operate before conducting any*

*operation based on the policy defined by the applicant.]*

#### OSO#20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission

*[SAIL II: Low robustness*

*What: 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.*

*Prove: 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.]*

### Adverse operating conditions

#### OSO#23 Environmental conditions for safe operations defined, measurable and adhered to

*[SAIL II: Low robustness*

*What: Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document*

*Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple record system.*

*Training covers assessment of meteorological conditions*

*Prove: The level of assurance of this element of the OSO needs to be assessed considering the criteria provided in section 9.*

*Procedures are not required to be validated against a recognized standard.*

*The adequacy of the procedures and checklists is declarative.*

*Training is self-declared (with evidence available)]*

## 4.11 Step #10 Comprehensive Safety Portfolio

# Appendix A: Abbreviations

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# Appendix B: Map of operation area

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# Appendix C. Estimation of maximum kinetic energy

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# Appendix D. Standard Operating Procedures

## Flight planning

* Flight Purpose
* Aircraft
* Payload
* Communications
* Support equipment
* Aircrew
* Airspace
* Route
* Altitude
* Airspeed
* Risk assessment

## Pre-flight

### Procedure during take-off

## Flight

### Procedure during landing

## Post flight

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# Appendix E. Contingency Procedures

# Appendix F. Emergency Response Plan

# Appendix G. Crew