Joint Authorities for Rulemaking of Unmanned Systems

JARUS guidelines on SORA

JARUS-STS-01

STANDARD SCENARIO FOR AERIAL WORK OPERATIONS:

- OVER SPARSELY POPULATED AREAS
- IN UNCONTROLLED AIRSPACE
- AT VERY LOW LEVELS
- BVLOS WITH VISUAL AIR RISK MITIGATION
- USING UNMANNED AIRCRAFT UP TO 3M DIMENSION (WINGSPAN OR ROTOR DIAMETER)

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1 Scope

This standard scenario (STS) is intended to cover UAS operations performed in the Specific category (category B) with the following main attributes:

- unmanned aircraft with a maximum characteristic dimension (e.g. wingspan or rotor diameter/area) up to 3 m and a typical kinetic energy up to 34 kJ,
- operated beyond visual line of sight (BVLOS) of the remote pilot with visual air risk mitigation,
- over sparsely populated areas,
- under 150m (500 ft) above the overflown surface (or any other altitude reference defined by the state), and
- in uncontrolled airspace

2 STS characterisation and provisions

Characterisation and provisions for this STS are summarised in Table 1: Summary of main limitations and provisions for JARUS-STS-01.

The applicant shall collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS. Annex A of SORA provides a detailed framework for data collection and presentation. The ConOps description is the foundation for all other activities and shall be as accurate and detailed as possible. The ConOps shall not only describe the operation, but also provide insight into the operator's operational safety culture. It shall also include how and when to interact with ANSP when applicable.

Table 1: Summary of main limitations and provisions for JARUS-STS-01

STS Characterisation and Provisions					
1. Operational characterisation (scope and limitations)					
Level of human intervention	• No autonomous operations: the remote pilot shall always be able to intervene in normal operation. • The remote pilot shall only operate one UA at a time. • The remote pilot shall not operate from a moving surface vehicle. • Hand-over between RPS shall not be performed				

Range limit from remote flight crew	• Launch / recovery: VLOS from the remote pilot
	• In flight:
	  ○ If no VOs are used: UA is not operated at more than 1 Km (or other distance defined by the competent authority) from the remote pilot.
	  ○ If VOs are used: range is not limited as long as the UA is not operated at more than 1 Km (or other distance defined by the competent authority) from the VO who is nearest to the UA.				

Overflown areas	**Sparsely populated** areas				
UA limitations	• Max. characteristic dimension (e.g. wingspan or rotor diameter/area): 3 m • Typical kinetic energy (as defined in SORA at §2.3.1) up to 34 kJ				
Flight height limit	The maximum height of the operational volume shall not be higher than 150m (500 ft) above the overflown surface (or any other altitude reference defined by the state). *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 the table)*				
Airspace	Operations shall be conducted only in F or G airspace class (uncontrolled airspace) over sparsely populated areas.				
Others	The use of the UA to drop material or carry dangerous goods (As per ICAO Doc 9284 - Technical Instructions for the Safe Transport of Dangerous Goods by Air) is forbidden, 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.				
Visibility	At no time shall the UA be operated in an area where minimum flight visibility is less than 5km.				
2. Operational risk classification (SORA)					
Final Ground Risk Class (GRC)	**3**	Final Air Risk Class (ARC)	**ARC-b**	SAIL	**II**

3. Operational mitigations	
Operational volume	The operational volume is composed of the flight geography and the contingency volume. To determine the operational volume the applicant shall consider the position keeping capabilities of the UAS in 4D space (latitude, longitude, height and time). 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 shall be considered and addressed in this determination If the UA leaves the operational volume, emergency procedures shall be activated immediately
Ground risk	• A ground risk buffer shall be established to protect third parties on the ground outside the operational volume. • The minimum criterion shall be the use of the “1 to 1 rule” (e.g. if the UA is planned to operate at 150m height, the ground risk buffer shall at least be 150m). • The operational volume, and the ground risk buffer shall be in sparsely populated environment. • The applicant shall evaluate the area of operations typically by means of an on-site inspection, or appraisal and can justify a lower density of people at risk
Air risk	An air risk buffer shall be defined. This air risk buffer shall be in F or G airspace class (uncontrolled airspace) over sparsely populated areas. Operational volume shall be out of an airport environment, as defined by the State of operations Prior to flight, the proximity of the planned operation to manned A/C activity shall be assessed.

Visual Observers	• The remote pilot shall determine the correct placement and number of VOs along the intended flight path. Prior to each flight, the operator shall perform following assessment:
	  ○ Check the compliance between visibility and planned range for VOs.
	  ○ The potential terrain obstruction for VOs shall be assessed.
	  ○ Confirm there are no gaps between the zones covered by each of the VOs
	• The VO(s) necessary for the safe conduct of the operation must be in place during flight operations.
	Note: remote pilot may perform the role of a VO provided that workload is adequate to perform his/her duties.

4. Operator provisions	

Operator competency	• The operator shall have:
	  ○ knowledge of the UAS being used, and
	  ○ relevant procedures including at least the following as a minimum: operational procedures (eg.checklists), maintenance, training, responsibilities, and duties.
	• Aforementioned aspect shall be addressed in the Concept of Operations (CONOPS – SORA Annex A)

UAS operations	• The following shall be defined and documented in an Operations Manual:
	  ○ Operational procedures and Emergency Response Plan (ERP).
	  ○ Limitations of the external systems supporting UAS for safe operations.
	  ○ Environmental conditions required for a safe operation.
	• Operational procedures shall be validated against standards recognised by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	• The adequacy of the contingency and emergency procedures shall be proved through:
	  ○ Dedicated flight tests, or
	  ○ Simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results, or
	  ○ Any other means acceptable to the competent authority.
	• The remote crew shall be competent and be authorised by the operator to carry out the intended operations.
	• A list of remote crew members authorised to carry out UAS operations is established and kept up to date.
	• A record of all relevant qualifications, experience and/or training completed by the remote crew is established and kept up to date.
	• The applicant shall have a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.

UAS maintenance	• The UAS maintenance instructions shall be defined, documented and cover the UAS manufacturer instructions and requirements when applicable. • The maintenance staff shall be competent and shall have received an authorisation to carry out maintenance. • The maintenance staff shall use the UAS maintenance instructions while performing maintenance. • The maintenance instructions shall be documented.

	• The maintenance conducted on the UAS shall be recorded in a maintenance log system. • A list of maintenance staff authorised to carry out maintenance shall be established and kept up to date. • A record of all relevant qualifications, experience and/or training completed by the maintenance staff shall be established and kept up to date. The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative.
External services	• The applicant shall 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 applicant shall declare that this adequate level of performance is achieved. • Roles and responsibilities between the applicant and the external service provider shall be defined.
5. Training provisions	
Remote crew	• Before performing UAS operations the remote crew shall have received competency-based theoretical and practical training consisting of the elements indicated in SORA Appendix E, and JARUS WG1 recommendations. • The training programme shall be documented (at least the training syllabus shall be available)
Maintenance staff	Maintenance staff must be competent and able to follow manufacturer instructions. A record of all relevant qualifications, experience and/or trainings completed by the maintenance staff is established and kept up to date.
6. Technical provisions	
General	• Means to monitor critical parameters for a safe flight shall be available, in particular: ○ UA position, height or altitude, ground speed or airspeed, attitude and trajectory; ○ UAS energy status (fuel, batteries …); ○ Status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS …) means shall be provided to monitor the adequate performance and triggering an alert if level is becoming too low. • The UA shall have the performance capability to descend safely from its operating altitude to a 'safe altitude' in less than a minute, or have a descend rate of ≥ 2.5 m/s (500 fpm) as defined in §5.1.3-"Contingency procedures"

Human machine Interface	• The UAS information and control interfaces shall be clearly and succinctly presented and shall not confuse, cause unreasonable fatigue, or contribute to remote flight crew error that could adversely affect the safety of the operation. • If an electronic means is used to support Visual Observers in their role to maintain awareness of the position of the unmanned aircraft, its HMI shall: ○ Be sufficient to allow the Visual Observers to determine the position of the UA during operation; ○ Not degrade the Visual Observer's ability to: ▪ Perform unaided visual scanning of the airspace where the UA is operating for any potential collision hazard; and ▪ maintain effective communication with the remote pilot at all times. • The applicant shall conduct an evaluation of the UAS considering and addressing human factors to determine the HMI is appropriate for the mission.
Command, Control links (C2) and communication	• The UAS shall comply with the appropriate requirements for radio equipment and the use of RF spectrum. • Protection mechanisms against interference shall be used, especially if unlicensed bands (e.g. ISM) are used for C2 Link (mechanisms like Frequency Hopping Spread Spectrum – FHSS, technology or frequency de-confliction by procedure) • Communication between remote pilot and VO shall allow for the remote pilot to manoeuvre the UA with sufficient time to yield right-of-way in accordance with the following provisions: ○ The unmanned aircraft must yield the right of way to all aircraft and airborne vehicles. ○ No person may operate an unmanned aircraft close to another aircraft so as to create a collision hazard.
Tactical mitigation	• 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. • Where an electronic means is used to assist the remote pilot and/or VOs in being aware of UA position in relation to potential "airspace intruders", the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.
Containment	To ensure a safe recovery from a technical issue involving the UAS, or external system supporting the operation, the operator shall ensure: • No probable failure of the UAS or any external system supporting

	the operation shall lead to operation outside of the operational volume. • It shall be reasonably expected that a fatality will not occur from any probable failure of the UAS, or any external system supporting the operation. Vertical extension of the operational volume shall be 500ft AGL (or any other altitude reference defined by the state). 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.” • A design and installation appraisal shall be made available and shall minimally include: o design and installation features (independence, separation and redundancy); o particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps. The 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. • 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 Abbreviations and definitions

3.1 Abbreviations

ADS-B	Automatic Dependent Surveillance – Broadcast
AGL	Above Ground Level
AltMoC	Alternative Means of Compliance
AMC	Acceptable Means of Compliance
ARP	Aerodrome Reference Point
ATC	Air Traffic Control
ATZ	Aerodrome Traffic Zone
BVLOS	Beyond Visual Line Of Sight
C2	Command and Control
CBT	Competency-Based Training
CBTA	Competency-Based Training and Assessment
CONOPS	Concept of Operations
EASA	European Aviation Safety Agency
EMI	Electro-Magnetic Interference
ERP	Emergency Response Plan
EU	European Union
FCL	Flight Crew Licensing
GM	Guidance Material
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
ICT	Information and Communication Technologies
ID	Identification
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
MCC	Multi-Crew Cooperation
METAR	Meteorological Terminal Air Report
MS	Member State
MTOM	Maximum Take-Off Mass
NOTAM	Notice To Airman
OM	Operations Manual
RLOS	Radio Line Of Sight
RP	Remote Pilot
RPS	Remote Pilot Station
SOP	Standard Operating Procedures
SORA	Specific Operations Risk Assessment
SPO	Specialised Operation(s)
STS	Standard Scenario
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
VLL	Very Low Level
VLOS	Visual Line of Sight
VO	Visual Observer

3.2 Definitions

- '**Flight geography**' means a geographically defined volume (or chained set of volumes), which can be spatially and temporally defined, that is wholly contained within Operation Volume. The Flight Geography represents the desired intent of the UAS Operator. See Figure 1: SORA semantic model and Figure 2: Graphical Representation of SORA Semantic Model.
- '**Contingency volume**' means the area outside of Flight Geography where contingency procedures are applied to return the operation to its desired state. See Figure 1: SORA semantic model and Figure 2: Graphical Representation of SORA Semantic Model.
- '**Operational volume**' is the combination of the Flight Geography and Contingency Volume. See Figure 1: SORA semantic model and Figure 2: Graphical Representation of SORA Semantic Model.
- '**Remote flight crew**' means the persons directly involved in the UAS operation, as defined by the UAS operator, e.g. remote pilot, visual observer ...
- '**Semantic model**' means the model used in JARUS SORA that correlates phases of operation, procedures, and operational volumes, as represented in the Figure 1: SORA semantic model.

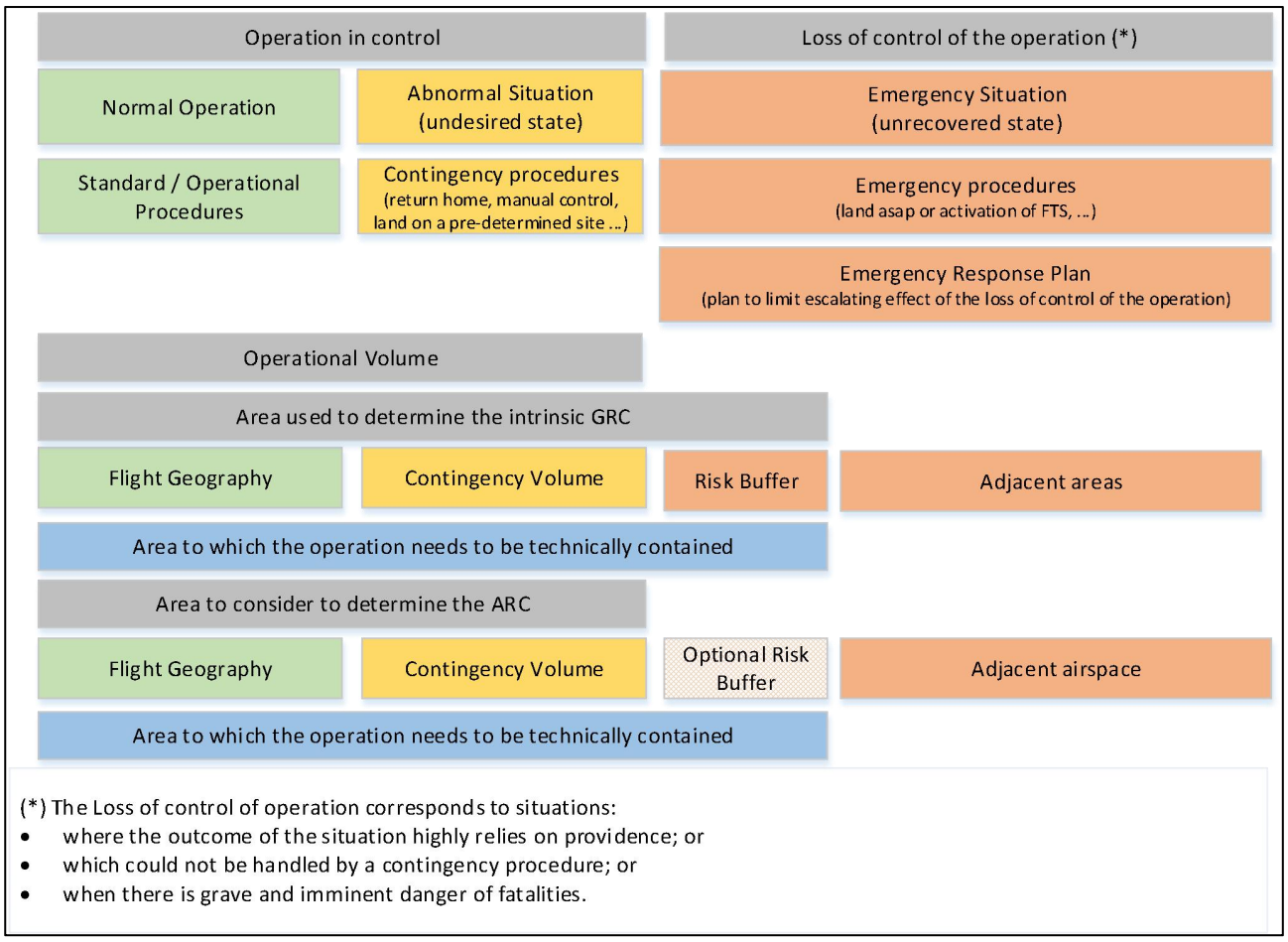

Figure 1: SORA semantic model

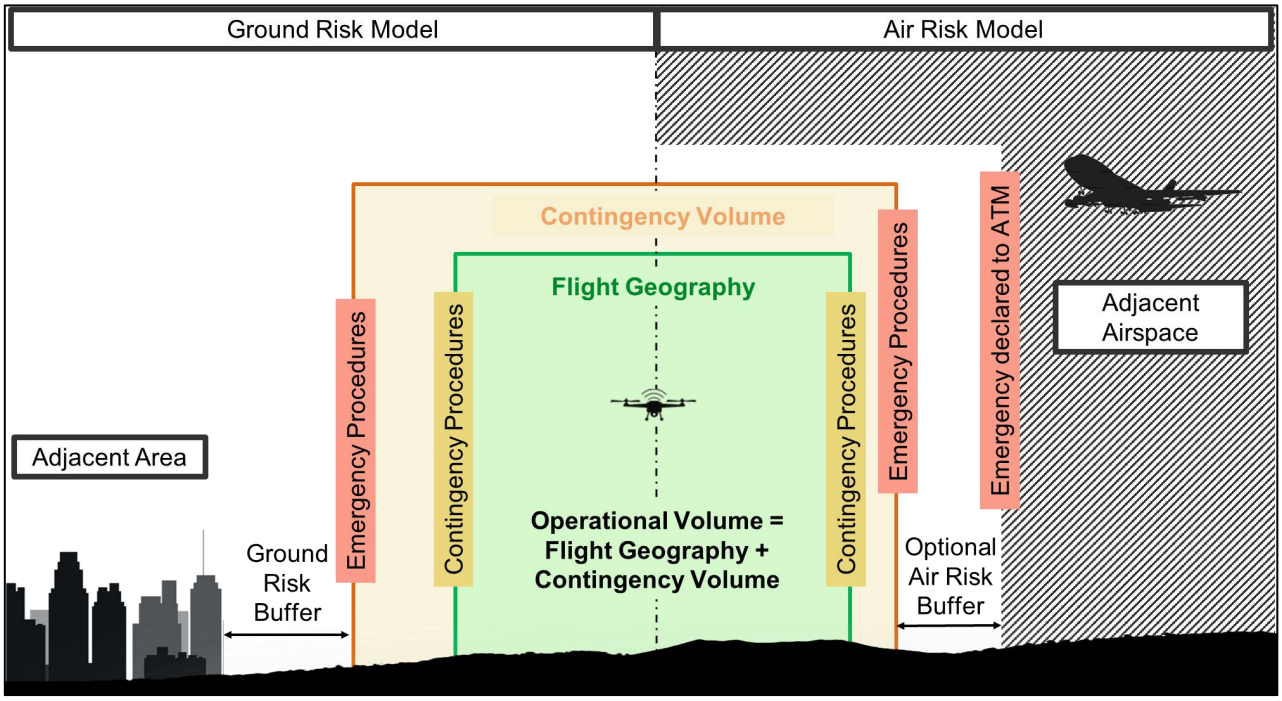

Figure 2: Graphical Representation of SORA Semantic Model

4 Reference documents

1	Specific Operations Risk Assessment (SORA)	JAR-DEL-WG6-D.04
2	JARUS guidelines on SORA - Annex B - Integrity and assurance levels for the mitigations used to reduce the intrinsic Ground Risk Class	JAR-DEL-WG6-D.04 – Annex B
3	JARUS guidelines on SORA - Annex C - Strategic Mitigation Collision Risk Assessment	JAR-DEL-WG6-D.04 – Annex C
4	JARUS guidelines on SORA - Annex D - Tactical Mitigation Collision Risk Assessment	JAR-DEL-WG6-D.04 – Annex D
5	JARUS guidelines on SORA - Annex E - Integrity and assurance levels for the Operation Safety Objectives (OSO)	JAR-DEL-WG6-D.04 – Annex E

Table 2: reference documents

5 APPENDIX A: OPERATIONS MANUAL

5.1 Operational procedures

5.1.1 General

Operational procedures 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.

The limitations of the external systems used to support UAS safe operations are defined in an Operation Manual.

Operational procedures shall consider human errors and shall include at least:

- a clear distribution and assignment of tasks,
- an internal checklist to check that staff is properly performing assigned tasks adequately

Note: In order to help a proper identification of the procedures related to deterioration of external systems supporting the UAS operation, it is recommended to:

- identify the “external systems” supporting the operation,
- describe the deterioration modes of these “external systems” which would prevent maintaining a safe operation of the UAS (e.g. complete loss of GNSS, drift of the GNSS, latency issues, …),
- describe the means put in place to detect the deterioration modes of the external systems/facilities,

- describe the procedure(s) in place once a deterioration mode of one of the external systems/facilities is detected (e.g. activation of the Emergency Recovery Capability, switch to a Manual control …).

5.1.2 Normal procedures

Normal procedures shall cover at least the following points:

(1) Operation preparation and planning, including the assessment of:
   i. the area of operation and surrounding area, including the terrain and potential obstacles, potential overflown people groups, potential overfly of critical infrastructure …

      Note: A risk assessment of critical infrastructure should be performed in cooperation with the responsible organization for the infrastructure, as they are most knowledgeable of the threats.

   ii. surrounding airspace, including:
      - the proximity of restricted zones and potential activities by other airspace users …
      - Check the compliance between visibility and planned range for VOs.
      - Assess the potential terrain obstruction for VOs.
      - Confirm there are no gaps between the zones covered by each of the VOs.
   iii. environmental conditions (How to determine the adequacy of the planned UAS operation within defined environmental conditions);
   iv. the required remote crew members and their responsibilities;
   v. the required communication procedures among remote crew members and with external parties when needed (e.g. ATC);
   vi. the UAS and any other technical means to be used in the operation, including the assessment of their suitability and their fitness (e.g. airworthy condition) and compliance with required performance (e.g. required C2 Link performance) for a safe conduct of the intended operation.
   vii. compliance with any specific requirement from the relevant authorities in the intended area of operations, including those related to security, privacy, environmental protection, use of RF spectrum, etc.;
   viii. the required risk mitigations (in addition to the above) being in place to ensure the safe conduct of the operation;

(2) Pre-flight inspection procedures, which shall be:
   i. performed by the remote flight crew to ensure the UAS is in a condition for safe operation and conforms to the concept of operations (CONOPS), and
   ii. documented (at least as part of the manufacturer's instructions and requirements)

(3) Launch & (normal) recovery procedures

(4) (Normal) In-flight procedures (including those to ensure that the UA remains within the "flight geography" volume)

(5) Post-flight (after recovery) procedures (including the corresponding inspections)

(6) Detection procedures of potentially conflicting aircraft by Remote Pilot and potential Visual Observers

5.1.3 Contingency procedures

Contingency procedures shall at least contain:

(1) Procedures to cope with the UA leaving the desired "flight geography"
(2) Procedures to cope with the UA entering the "containment" area.
(3) 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)
(4) Procedures to cope with the deterioration of external systems supporting the operation (see §5.1.1-"General")
(5) De-confliction scheme, i.e. the criteria that will be applied for the decision to avoid incoming traffic. In cases where the detection is performed by Visual Observers (VOs), the use of clear phraseology shall be established.
(6) Avoidance procedures
Avoidance manoeuvres may rely on performing a rapid descent to a safe altitude, or an immediate rapid landing (when a cleared landing space can be verified prior to descent).

5.1.4 Emergency procedures

Emergency procedures to cope with emergency situations (where there is a loss of control of the operation that cannot be recovered), including at least:

(1) Procedures to avoid or, at least minimise, harm to third parties in the air or on the ground. With regard to the air risk, an avoidance strategy to minimize the collision risk with another airspace user (in particular, an aircraft with people on board) shall be included.
(2) Procedures for the emergency recovery of the UA (e.g. land immediately, termination of the flight with FTS or controlled crash/splash …)

5.1.5 Emergency Response Plan (ERP)

The operator shall establish an ERP that:

- is expected to cover:
  - the plan to limit crash escalating effect (e.g. notify emergency services and other relevant authorities), and
  - the conditions to alert ATM.
- is suitable for the situation;
- limits the escalating effects;
- defines criteria to identify an emergency situation;
- is practical to use;
- clearly delineates Remote Crew member(s) duties.
- is developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[1].
- is validated through a representative table top exercise[2] consistent with the ERP training syllabus.

[1] National Aviation Authorities may define the standards and/or the means of compliance they consider adequate. The SORA AnnexB will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.
[2]The table top exercise may or may not involve all third parties identified in the ERP.

The operator shall provide competency-based theoretical and practical training covering the ERP that includes related proficiency requirements and training recurrences.

The ERP training syllabus shall be presented for inspection upon request from the competent authority or authorised representative of the competent authority.

6 APPENDIX B: TRAINING

6.1 Remote crew

The following are provisions applicable to UAS operators in relation to ensure proficiency, competency and clear duty assignment to the flight crew. UAS operators may decide to expand these requirements as applicable to its operation.

6.1.1 Remote flight crew training and qualification

The operator shall ensure the entire remote crew (i.e. any person involved in the operation) are provided with competency-based theoretical and practical training specific to their duties that consists of the following elements:

- Basic competencies from the competency framework necessary to ensure safe flight:
  - UAS regulation
  - UAS airspace operating principles
  - Airmanship and aviation safety
  - Human performance limitations
  - Meteorology
  - Navigation/Charts
  - UA knowledge
  - Operating procedures
  - assignment of tasks to the crew,
  - establishment of step-by-step communications
  - Coordination and handover

  And shall be adequate for the operation
- Familiarization with CAT B (Specific Category).

Evidence of training shall be presented for inspection upon request from the competent authority or authorised representative.

6.1.2 Visual observers

Visual Observer main responsibility shall be to:

(1) Perform unaided visual observation of the operation area and perform unaided visual scanning of the airspace where the UA is operating for any potential hazard in the air;
(2) maintain awareness of the position of the UA through direct visual observation or through assistance provided by an electronic means; and
(3) alert the remote pilot in case a hazard is detected and assist in avoiding or minimising the potential negative effects.

6.1.3 Remote Pilot

The remote pilot has the authority to cancel or delay any or all flight operations under the following conditions:

(1) the safety of persons, or

(2) property on the ground or

(3) other airspace users are in jeopardy or

(4) There is a violation of the terms of this authorisation.

If VOs are used, then remote pilot shall ensure that the necessary VOs are available and correctly placed, and that the communications with them can be adequately performed.

The remote pilot shall ensure that the UA remains clear of clouds, and that the ability of remote pilot, or one of the VOs to perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard is not hampered by clouds.

6.1.4 Multi-crew cooperation (MCC)

In applications where MCC might be required, the UAS operator shall:

(1) include in the SOP (section 4.1.2) procedures to ensure a coordination between the remote flight crew members with robust and effective communication channels. Those procedures shall cover as a minimum:
   i. assignment of tasks to the remote flight crew members,
   ii. establishment of a step-by-step communication.
(2) ensure that the training of remote flight crew covers MCC.

6.1.5 Remote crew fit to operate

The operator shall have a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.

The remote crew shall declare they are fit to operate before conducting any operation based on the policy defined by the applicant.

6.2 Maintenance staff

Maintenance personnel shall be trained to the documented maintenance procedures. Evidence of training shall be presented for inspection upon request from the competent authority or authorised representative.

The operator may declare the maintenance team has received training to documented maintenance procedures; however, evidence of this training shall be made available upon request from the competent authority or authorised representative.

7 APPENDIX C: EXPLANATORY NOTE AND RISK ASSESSMENT FOR JARUS-STS-01

7.1 Explanatory Note

The standard scenario JARUS-STS-01 is intended to provide an operational framework where many of current and expected operations in the CAT B can fit.
To allow a wide enough range of different operational needs, this STS was written in a non-prescriptive manner.
Most requirements in the JARUS-STS-01 scenario are directly derived from the SORA criteria for the corresponding level of risk (SAIL).
Since many of the criteria for integrity (see SORA) are applicable all operations in the CAT B (as the same criteria applies for all levels of robustness), those criteria have been considered as general provisions in Subpart A of the JARUS-STS-01. Criteria that are specific to the allocated level of robustness (in many cases, those relate to the level of assurance) have been included as specific provisions for the JARUS-STS-01.
Next section of this document includes the SORA process applied to this STS to show that the proposed provisions are sufficiently robust and consistent with the methodology.

7.2 Risk assessment based on SORA

The proposed standard scenario (STS) is assessed following the process described in JARUS SORA as follows

7.2.1 Pre-application evaluation

7.2.1.1 Step #1 – CONOPS description

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

Generally, applicants will need to provide the competent authority with their CONOPS (see JARUS SORA annex A) as part of the substantiation package.

7.2.2 Ground Risk Process

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

The initial UAS ground risk relates to the unmitigated risk of a person being struck by the UA (in case of loss of UAS control) and can be represented by the Ground Risk Classes (GRC) derived from the intended operation and the UAS lethal area, as shown in Table 3 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 3: Determination of the intrinsic UAS Ground Risk Class (GRC) (source: SORA Main Body)

From the limitations defining the proposed STS:

- Operational scenarios: BVLOS over sparsely populated environment (over-flown areas uniformly inhabited with low population density)
- UA characteristics:
  - Up to 3m of characteristic dimension (e.g. wingspan or rotor diameter)
  - Typical expected maximum kinetic energy of 34 kJ

Thus, the maximum Intrinsic UAS GRC, as highlighted in Table 3, is:

Intrinsic GRC = 4

7.2.2.2 Step #3 – Final GRC determination

As indicated in SORA, s*ince mitigations used to modify the intrinsic GRC have a direct effect of the safety objectives associated with a particular operation, it is especially important to ensure their robustness. This aspect assumes extreme relevance in those cases where harm barriers are of a technological nature (e.g. emergency parachute). This step of the process allows for determination of the final GRC based on the availability of these mitigations to the operation. Table 4: Mitigations for Final GRC determination (source: SORA Main Body) provides a list of these mitigations and the relative correction factor. A positive number denotes an increase of the GRC while a negative number results in a decrease of the GRC. All barriers have to be considered in order to perform the assessment. Annex B of SORA provides additional details on how to estimate the robustness of each mitigation. Competent authorities may define additional mitigations and the relative correction factors*.

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

- **M1 - Strategic mitigations for ground risk** with a “Low” level of robustness and, consequently:
  - Regarding integrity:
    - Criterion #1 (Definition of the ground risk buffer)
      - ✓ The applicant shall define a ground risk buffer with at least a 1 to 1 rule[1].

        [1] If the UA is planned to operate at an altitude of 150m altitude, the ground risk buffer shall be at least be a minimum of 150m.
    - Criterion #2 (Evaluation of people at risk)
      - ✓ The applicant shall evaluate 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.
  - Regarding assurance:
    - Criterion #1 (Definition of the ground risk buffer)
      - ✓ The applicant shall declare that the required level of integrity has been achieved.
    - Criterion #2 (Evaluation of people at risk)
      - ✓ The applicant shall declare that the required level of integrity has been achieved.
    - 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 and, consequently:
  - Regarding integrity:
    - An Emergency Response Plan (ERP) shall be defined by the applicant to cope with cases of loss of control of the operation. These are emergency situations where the operation could result in an unrecoverable state.
    - These are cases in which:
      - ✓ the outcome of the situation highly relies on providence; or
      - ✓ could not be handled by a contingency procedure; or
      - ✓ 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 plan to limit the escalating effect of an eminent crash (e.g. notify first responders), and
      - ✓ the conditions to alert ATM
    - The ERP shall
      - ✓ be suitable for the situation;
      - ✓ limit the escalating effects;
      - ✓ define criteria to identify an emergency situation;
      - ✓ be practical to use;
      - ✓ clearly delineate Remote Crew member(s) duties.
  - Regarding assurance:
    - Criterion #1 (Procedures)
      - ✓ The ERP shall be developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[1].
      - ✓ The ERP shall be validated through a representative tabletop exercise[2] consistent with the ERP training syllabus.

        [1] National Aviation Authorities may define the standards and/or the means of compliance they consider adequate.

        The SORA Annex E will be updated at a later point in time with a list of adequate standards based on the feedback provided by the NAAs.

        [2]The tabletop exercise may or may not involve all third parties identified in the ERP
    - Criterion #2 (Training)
      - ✓ Training syllabus shall be available
      - ✓ Competency-based theoretical and practical training shall be organised by the operator

Therefore, as highlighted in Table 4, the result is that there is no correction to the Intrinsic GRC and, consequently, the **Final GRC is** equal to the Intrinsic/Initial GRC, which is **3**.

		Robustness			Correction
Mitigation Sequence	**Mitigations for ground risk**	**Low / None**	**Medium**	**High**	
1	M1 - Strategic mitigations for ground risk[1]	**0: None -1: Low**	**-2**	**-4**	**-1**
2	M2 - Effects of ground impact are reduced[2]	**0**	**-1**	**-2**	**0**
3	M3 - An Emergency Response Plan (ERP) is in place, operator validated and effective	**1**	**0**	**-1**	**0**
Total correction					**-1**

Table 4: Mitigations for Final GRC determination (source: SORA Main Body)

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

7.2.3 Air Risk Process

7.2.3.1 Step #4 – Determination of the Initial Air Risk Class

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

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

- below 150 m/ 500 ft AGL (or any other altitude reference defined by the state);
- F or G airspace class (uncontrolled airspace) over sparsely populated area(s);

Then, the Air Risk Classes (ARCs) associated to this STS are shown in diagram of Figure 3: ARC determination process (source: adapted from SORA Main Body).

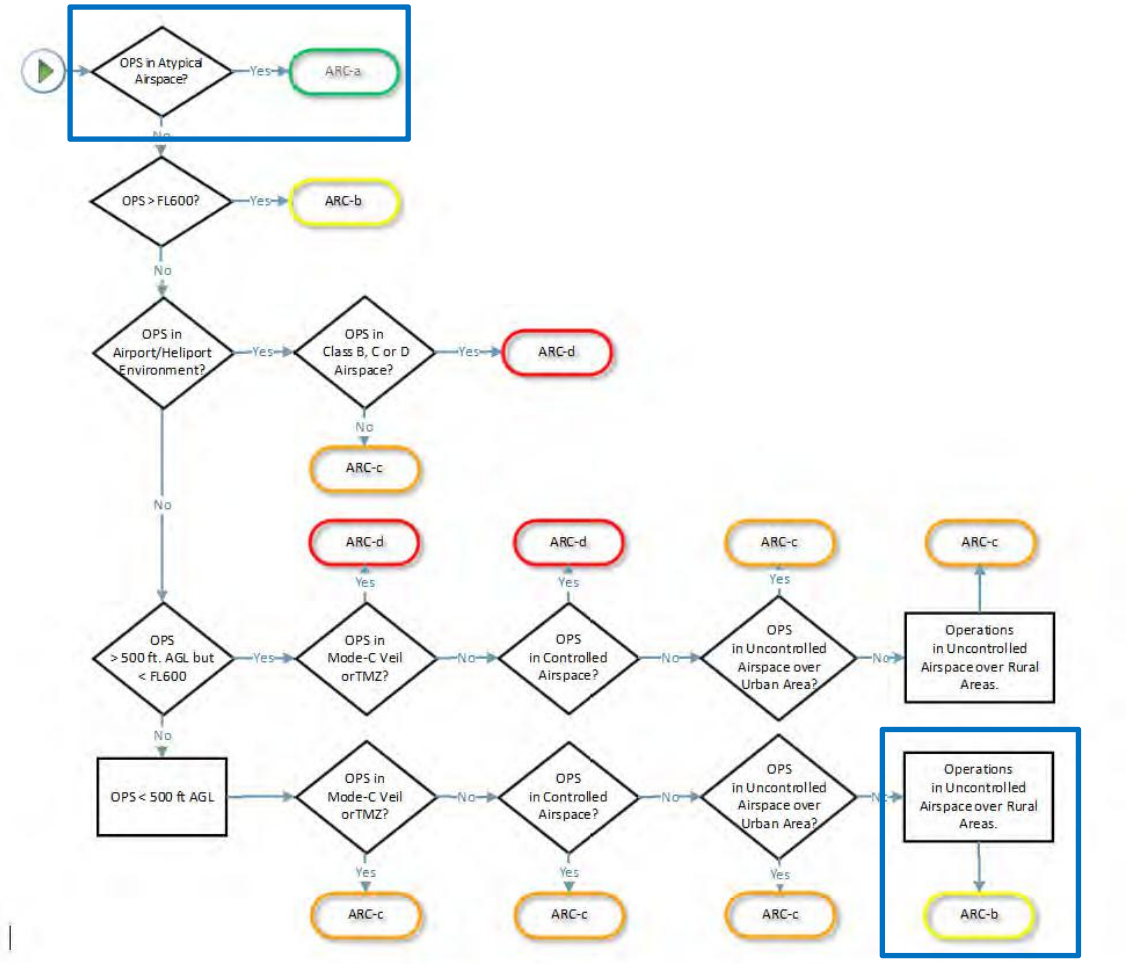

Figure 3: ARC determination process (source: adapted from SORA Main Body)

Therefore, operations under this STS would have an ARC-a and ARC-b, as defined in SORA Annex C. However, since the latter leads to higher robustness requirements, **ARC-b is considered for this STS as conservative approach to the air risk**.

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

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

Final ARC = ARC-b

7.2.3.3 Step #6 – Tactical Mitigation Performance Requirement (TMPR) and Robustness Levels

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

As indicated in Table 5 below, the required level for Tactical Mitigation Performance Requirement (TMPR) and TMPR robustness is **low**.

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

Table 5: Tactical Mitigation Performance Requirement (TMPR) and TMPR Level of Robustness Assignment (source: SORA Main Body)

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

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

- TMPR using human "See and Avoid" schemas
  - A **VLOS limitation is included in this STS 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
  - If no VOs are used: UA is **not operated at more than 1 Km** (or other distance defined by MS) **from the remote pilot**.
  - If VOs are used: **range is not limited** as long as the UA is **not operated at more than 1 Km** (or other distance defined by MS) **from the VO who is nearest to the UA.**

- Regarding performance requirements for the "detect and avoid" functions, Table 6 below shows TMPR for ARC-b (TMPR Low) and TMPR considered in proposed mitigations for the STS.

		Tactical Mitigation Performance Requirements (TMPR)	
		In SORA for ARC-b (TMPR Low)	**In proposed mitigations for the STS**
Functions	Detect	The expectation is for the applicant's DAA Plan to enable the operator to **detect approximately 50% of all aircraft in the detection volume**[3]. 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[4]/Pilot Aware[4] aircraft trackers • Use of UTM Dynamic Geofencing[5] • Monitoring aeronautical radio communication (i.e. use of a scanner)[6]	The limitation of **not having the UA operating further than 1 Km** from the remote pilot or a VO, allows the remote flight crew to perform unaided visual **scanning of the airspace** where the UA is flying in, which can reasonably expected to enable the operator to **detect at least 50% of all aircraft in the detection volume**. No specific means for tactical mitigation are indicated in the STS but provisions in case of their use are included (see "integrity requirements")
	Decide	The operator must have a **documented de-confliction scheme**, in which the operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing a 2NM (3.7km) boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'DESCEND! DESCEND! DESCEND!'	Operating procedures must be documented, which include the contingency procedures containing the de-confliction scheme. This de-confliction scheme must include the following aspects for the decision-making process: • Decision criteria: if the incoming traffic is detected at 5km (2NM+1km) or less and at 1000 ft (~300 m) or less, the avoidance manoeuvre should be initiated. • Pre-defined phraseology to warn the remote pilot in case the detection is performed by a VO, e.g. 'DESCEND! DESCEND! DESCEND!'

[3] The size of the detection volume depends on the aggravated closing speed of traffic that may be reasonably be encountered, the time required by the remote pilot to command the avoidance manoeuvre, the time required by the system to respond and the manoeuvrability and performance of the aircraft. The detection volume is proportionally larger than the alerting threshold.

[4] FLARM and PilotAware are commercially available (trademarked) products/brands. They are referenced here only as example technologies. The references do not imply an endorsement by JARUS or the authors of this document for the use of these products. Other products offering similar functions may also be used.

[5] These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today. A subscription to these services may be required.

[6] If permitted by the authority. May require a Radio-License or Permit.

		Tactical Mitigation Performance Requirements (TMPR)	
		In SORA for ARC-b (TMPR Low)	**In proposed mitigations for the STS**
	Command	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command must not exceed 5 seconds.	The criteria from SORA are considered part of the technical provisions for the UAS and supporting means, in particular: 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.**
	Execute	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.	Avoidance manoeuvres may rely on performing a rapid descent to a safe altitude, or an immediate rapid landing (when a cleared landing space can be verified prior to descent). The aircraft should have the performance capability to descend safely from its operating altitude to the 'safe altitude' in less than a minute or have a descend rate of ≥ 500 feet per minute.
	Feedback Loop	Where **electronic means assist the remote pilot in detecting traffic**, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed **3 NM threshold, a 5 second update rate and a latency of 10 seconds** is considered adequate (see example below).	The criteria from SORA are considered part of the technical provisions for the UAS and supporting means, in particular: • Where an **electronic means is used to assist the remote pilot and/or VOs in being aware of UA position in relation to potential "airspace intruders"**, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.

Table 6: SORA TMPR for ARC-b (low level) and TMPR of proposed mitigations in the STS (source: based on SORA)

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

Note: The requirement is expected to be met by commercially available products. No quantitative analysis is required.

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

Aerial Work operations may be conducted BVLOS of the remote pilot using VOs to satisfy right of way requirements under the following operational limitations as approved by the competent authority.

Following requirements are proposed to support the BVLOS with unaided visual air risk mitigation concept:

- The remote pilot shall determine the correct placement and number of VOs along the intended flight path. Prior to each flight, the operator shall perform following assessment:
  - Check the compliance between visibility and planned range for VOs.
  - The potential terrain obstruction for VOs shall be assessed.
  - Confirm there are no gaps between the zones covered by each of the Vos
- At all times during the flight, the remote pilot or one of the VOs shall:
  - Perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard; and
  - Maintain awareness of the position of the unmanned aircraft through direct visual observation or though assistance provided by an electronic means.
- Communication between remote pilot and VO shall allow for the remote pilot to manoeuvre the UA with sufficient time to yield right-of-way in accordance with the following provisions:
  - The unmanned aircraft must yield the right of way to all aircraft and airborne vehicles.
  - No person may operate an unmanned aircraft so close to another aircraft so as to create a collision hazard.
- The remote pilot shall ensure that the UA remains clear of clouds, and that the ability of remote pilot and VO to perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard is not hampered by clouds.
- At no time shall the UA be operated in an area where minimum flight visibility is less than 5km (2NM + 1km rounded up).
- The remote pilot shall not be responsible for more than one UAS operation at a time.
- The remote pilot shall be able to determine the position, speed, attitude, altitude, and trajectory of the UA during operations.
- The VO(s) necessary for the safe conduct of the operation must be in place during flight operations.
- The UA shall not be operated more than 1km away (or other distance defined by NAA) from the remote pilot or VO nearest to the UA.

7.2.4 Final SAIL and Operational Safety Objectives (OSO) Assignment

7.2.4.1 Step #7 – SAIL determination

Considering that:

- Ground risk: final GRC is 3.
- Air risk: final ARC is ARC-b (conservative approach as earlier indicated, since the STS also includes operations in "atypical" airspace → ARC-a)

Then, the resulting **SAIL for this STS is II**, as indicated in Table 7 below:

SAIL Determination				
	Final ARC			
Final GRC	a	b	c	d
1	**I**	**II**	**IV**	**VI**
2	**I**	**II**	**IV**	**VI**
3	**II**	**II**	**IV**	**VI**
4	**III**	**III**	**IV**	**VI**
5	**IV**	**IV**	**IV**	**VI**
6	**V**	**V**	**V**	**VI**
7	**VI**	**VI**	**VI**	**VI**
>7	Category C (certified) operation			

Table 7: SAIL determination (source: SORA Main Body)

7.2.4.2 Step #8 – Identification of Operational Safety Objectives (OSOs)

As indicated in SORA:

- The purpose of this step is to evaluate the defenses within the operation in form of operational safety objectives (OSOs) and the associated level of robustness depending on the SAIL.
- Table 8, from SORA, provides a qualitative methodology to make this determination. In this table, O is Optional, L is recommended with Low robustness, M is recommended with Medium robustness, H is recommended with High robustness. The various OSOs are grouped based on the threat they help to mitigate. Some OSOs may therefore be repeated in the table.
- Table 8 provides a consolidated list of common OSOs that have been historically used to ensure safety of UAS operations. It collects the experience of many experts and is therefore a solid starting point to determine the required safety objectives for a specific operation. Competent authorities may define additional OSOs and the relative level of robustness.

SAIL II corresponding to this STS is highlighted in Table 8 to show the required level of robustness for the different OSOs

OSO Number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure the operator is competent and/or proven	O	L	M	H	H	H
OSO#02	UAS manufactured by competent and/or proven entity	O	O	L	M	H	H
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H
OSO#04	UAS developed to authority recognized design standards[7]	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

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

OSO Number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
OSO#09	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#10	Safe recovery from technical issue	L	L	M	M	H	H
	Deterioration of external systems supporting UAS operation						
OSO#11	Procedures are in-place to handle the deterioration of external systems supporting UAS operation	L	M	H	H	H	H
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operation	L	L	M	M	H	H
OSO#13	External services supporting UAS operations are adequate to the operation	L	L	M	H	H	H
	Human Error						
OSO#14	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#15	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#16	Multi crew coordination	L	L	M	M	H	H
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H
OSO#18	Automatic protection of the flight envelope from Human Error	O	O	L	M	H	H
OSO#19	Safe recovery from Human Error	O	O	L	M	M	H
OSO#20	A Human Factors evaluation has been performed and the HMI found appropriate for the mission	O	L	L	M	M	H
	Adverse operating conditions						
OSO#21	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#22	The remote crew is trained to identify critical environmental conditions and to avoid them	L	L	M	M	M	H
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L	L	M	M	H	H
OSO#24	UAS designed and qualified for adverse environmental conditions	O	O	M	H	H	H

Table 8: Recommended operational safety objectives (OSOs) (source: SORA Main Body)

7.2.5 Step #9 – Adjacent Area/Airspace Considerations

Here is below an extract of SORA main Body §2.5.3- "Step #9 – Adjacent Area/Airspace Consideration":

- *The objective of this section is to address the risk posed by a loss of control of the operation resulting in an infringement of the adjacent areas on the ground and/or adjacent airspace. These areas may vary with different flight phases.*
- *Safety requirements for containment:*

  No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.

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

  - *design and installation features (independence, separation and redundancy);*
  - *particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps.*
- *For operations conducted:*
  - *Where adjacent areas are:*
    - *i. Gatherings of people unless already approved for operations over gathering of people OR*
    - *ii. ARC-d unless the residual ARC is ARC-d*
  - *In populated environments where*
    - *i. M1 mitigation has been applied to lower the GRC*
    - *ii. Operating in a controlled ground area*

  The following safety requirements apply:

  1. *The probability of leaving the operational volume shall be less than 10-4/FH.*
  2. *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.

  3. *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.*

In the context of this STS following requirements apply:

- No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.

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

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

7.2.6 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 STS, under this step the compliance of proposed provisions for the STS against SORA criteria is performed as shown below:

- For Mitigations used to modify the intrinsic GRC, “Table 9: Compliance check of STS proposed provisions against SORA criteria for Mitigations used to modify the intrinsic GRC (source: based on SORA)”
- For Strategic mitigations for the Initial ARC: N/A – The standard scenario does not take credit for strategic mitigations
- For Tactical mitigations for the Final ARC, “Table 10: Compliance check of STS proposed provisions against SORA criteria for Tactical Mitigations used for final ARC (source: based on SORA)”
- For Operational Safety Objectives, “Table 11: Compliance check of STS proposed provisions against SORA criteria for OSOs (source: based on SORA)”
- For Adjacent Area/Airspace Consideration, “Table 12: Compliance check of STS proposed provisions against SORA criteria for Mitigations used for Containment objectives (source: based on SORA)”

7.2.6.1 Mitigations used to modify the intrinsic GRC,

Mitigations used to modify the intrinsic GRC		**level of robustness**	**Criteria in SORA**	**Provisions for the STS**

M3 - An Emergency Response Plan (ERP) is in place, operator validated and effective	LEVEL of INTEGRITY	Medium	An Emergency Response Plan (ERP) shall be defined by the applicant to cope with cases of loss of control of the operation. These are emergency situations where the operation could result in an unrecoverable state.
			These are cases in which:
			• the outcome of the situation highly relies on providence; or
			• could not be handled by a contingency procedure; or
			• 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 plan to limit the escalating effect of an eminent crash (e.g. notify first responders), and
			• the conditions to alert ATM
			The ERP shall:
			• be suitable for the situation;
			• limit the escalating effects;
			• define criteria to identify an emergency situation;
			• be practical to use;
			• clearly delineate Remote Crew member(s) duties.
				It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1.5-"Emergency Response Plan (ERP)" that:
				The operator shall establish an ERP that:
				• is expected to cover:
				  ○ the plan to limit crash escalating effect (e.g. notify emergency services and other relevant authorities), and
				  ○ the conditions to alert ATM.
				• is suitable for the situation;
				• limits the escalating effects;
				• defines criteria to identify an emergency situation;
				• is practical to use;
				• clearly delineates Remote Crew member(s) duties.

	LEVEL of ASSURANCE		Criterion #1 (Procedures) • The ERP shall be developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[1]. • The ERP shall be validated through a representative tabletop exercise[2] consistent with the ERP training syllabus. [1] National Aviation Authorities may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1.5-"Emergency Response Plan (ERP)" that: The operator shall establish an ERP that: • is developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[1]. • is validated through a representative tabletop exercise[2] consistent with the ERP training syllabus. [1] National Aviation Authorities may define the standards and/or the means of compliance they consider adequate. The SORA Annex E will be updated at a later point in time with a list of

Mitigations used to modify the intrinsic GRC		**level of robustness**	**Criteria in SORA**	**Provisions for the STS**
			of adequate standards based on the feedback provided by the NAAs. [2]The tabletop exercise may or may not involve all third parties identified in the ERP	adequate standards based on the feedback provided by the NAAs. [2]The tabletop exercise may or may not involve all third parties identified in the ERP.
			Criterion #2 (Training) • Training syllabus shall be available • Competency-based theoretical and practical training shall be organised by the operator	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1.5-"Emergency Response Plan (ERP)" that: The operator shall provide competency-based theoretical and practical training covering the ERP that includes related proficiency requirements and training recurrences. The ERP training syllabus shall be presented for inspection upon request from the competent authority or authorised representative.
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 shall define a ground risk buffer with at least a 1 to 1 rule[1]. [1] If the UA is planned to operate at an altitude of 150m altitude, the ground risk buffer shall be at least be a minimum of 150m.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 3. Operational mitigations / Ground risk, that: • A ground risk buffer shall be established to protect third parties on the ground outside the operational volume. • The minimum criterion shall be the use of the "1 to 1 rule" (e.g. if the UA is planned to operate at 150m height, the ground risk buffer should at least be 150m).

Mitigations used to modify the intrinsic GRC		**level of robustness**	**Criteria in SORA**	**Provisions for the STS**
				• The operational volume, and the ground risk buffer shall be in sparsely populated environment.
			Criterion #2 (Evaluation of people at risk) The applicant shall evaluate 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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 3. Operational mitigations / Ground risk, that: • The applicant shall evaluate the area of operations typically by means of an on-site inspection, or appraisal and can justify a lower density of people at risk
	LEVEL of ASSURANCE		Criterion #1 (Definition of the ground risk buffer) The applicant shall declare that the required level of integrity has been achieved. Criterion #2 (Evaluation of people at risk) The applicant shall declare that the required level of integrity has been achieved. (Supporting evidence may or may not be available)	These information are gathered in applicant CONOPS

Table 9: Compliance check of STS proposed provisions against SORA criteria for Mitigations used to modify the intrinsic GRC (source: based on SORA)

7.2.6.2 Strategic mitigations for the Initial ARC

N/A – The standard scenario does not take credit of strategic mitigations

7.2.6.3 Tactical mitigations for the Final ARC

Tactical mitigations for the Final ARC		level of robustness	Criteria in Risk Assessment	Provisions for the STS
	LEVEL of INTEGRITY	Low	• The remote pilot shall determine the correct placement and number of VOs along the intended flight path. Prior to each flight, the operator shall perform following assessment: ○ Check the compliance between visibility and planned range for VOs. ○ The potential terrain obstruction for VOs shall be assessed. ○ Confirm there are no gaps between the zones covered by each of the Vos	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 3. Operational mitigations / Visual observers that: • The remote pilot shall determine the correct placement and number of VOs along the intended flight path. Prior to each flight, the operator shall perform following assessment: ○ Check the compliance between visibility and planned range for VOs. ○ The potential terrain obstruction for VOs shall be assessed. ○ Confirm there are no gaps between the zones covered by each of the Vos It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§ 5.1.2-"Normal procedures" that: Normal procedures shall cover at least the following points: … ii. surrounding airspace, including: ○ the proximity of restricted zones and potential activities by other airspace users … ○ Check the compliance between visibility and planned range for VOs. ○ Assess the potential terrain obstruction for VOs. ○ Confirm there are no gaps between the zones covered by each of the VOs.
			• At all times during the flight, the remote pilot or one of the VOs shall: ○ Perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard; and ○ Maintain awareness of the position of the unmanned aircraft through direct visual observation or though assistance provided by an electronic means.	It is written in §6-"APPENDIX B: TRAINING"/§ 6.1.2-"Visual observers" that: Visual Observer main responsibility shall be to: (1) Perform unaided visual observation of the operation area and perform unaided visual scanning of the airspace where the UA is operating for any potential hazard in the air (2) maintain awareness of the position of the UA through direct visual observation or though assistance provided by an electronic means;

Tactical mitigations for the Final ARC		level of robustness	Criteria in Risk Assessment	Provisions for the STS
				and (3) alert the remote pilot in case a hazard is detected and assist in avoiding or minimising the potential negative effects.
			• Communication between remote pilot and VO shall allow for the remote pilot to manoeuvre the UA with sufficient time to yield right-of-way in accordance with the following provisions: ○ The unmanned aircraft must yield the right of way to all aircraft and airborne vehicles. ○ No person may operate an unmanned aircraft so close to another aircraft so as to create a collision hazard.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-EVLOS-01 / 6. Technical provisions / Command, Control links (C2) and communication, that: • Communication between remote pilot and VO shall allow for the remote pilot to manoeuvre the UA with sufficient time to yield right-of-way in accordance with the following provisions: ○ The unmanned aircraft must yield the right of way to all aircraft and airborne vehicles. ○ No person may operate an unmanned aircraft so close to another aircraft so as to create a collision hazard.
			• The remote pilot shall ensure that the UA remains clear of clouds, and that the ability of remote pilot and VO to perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard is not hampered by clouds.	It is written in §6-"APPENDIX B: TRAINING"/§ 6.1-"Remote crew"/§ 6.1.1-"Remote flight crew training and qualification" that: The remote pilot shall ensure that the UA remains clear of clouds, and that the ability of remote pilot or one of the VOs to perform unaided visual scanning of the airspace where the unmanned aircraft is operating for any potential collision hazard is not hampered by clouds.
			• At no time shall the UA be operated in an area where minimum flight visibility is less than 5km.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / Specific limitations and provisions / 1. Operational characterisation (scope and limitations) / Visibility that: At no time shall the UA be operated in an area where minimum flight visibility is less than 5km.
			• The remote pilot shall not be responsible for more than one UAS operation at a time.	It is written in It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / Specific limitations and provisions / 1. Operational characterisation (scope and limitations) / Level of human intervention that: The remote pilot shall operate only one UA at a time.
			• The remote pilot shall be able to determine the position, speed, attitude, altitude, and trajectory of the UA during operations.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6.

Tactical mitigations for the Final ARC		level of robustness	Criteria in Risk Assessment	Provisions for the STS

				Technical provisions / General that:
				• Means to monitor critical parameters for a safe flight shall be available, in particular:
				  ○ UA position, height or altitude, ground speed or airspeed, attitude and trajectory);
				  ○ UAS energy status (fuel, batteries …);
				  ○ status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS …) means shall be provided to monitor the adequate performance and triggering an alert if level is becoming too low.

			• The VO(s) necessary for the safe conduct of the operation must be in place during flight operations.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 3. Operational mitigations / Visual observers that: The VO(s) necessary for the safe conduct of the operation must be in place during flight operations.

			• The UA shall not be operated more than 1km away (or other distance defined by NAA) from the remote pilot or VO nearest to the UA.	It is written in It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / Specific limitations and provisions / 1. Operational characterisation (scope and limitations) / Range limit from remote flight crew that
				• Launch / recovery: VLOS from the remote pilot
				• In flight:
				  ○ If no VOs are used: UA is not operated at more than 1 Km (or other distance defined by the competent authority) from the remote pilot.
				  ○ If VOs are used: range is not limited as long as the UA is not operated at more than 1 Km (or other distance defined by the competent authority) from the VO who is nearest to the UA.

			Performance requirements Detection capability • Scanning the airspace where the UA is operating for conflicting traffic satisfies the SORA requirement to have a DAA Plan that enable the operator to detect approximately 50% of all aircraft in the detection volume.	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§5.1.2 -"Normal procedures" that: Normal procedures shall cover at least the following points: ... (6) Detection procedures of potentially conflicting aircraft by Remote Pilot and potential Visual Observers

Tactical mitigations for the Final ARC		level of robustness	Criteria in Risk Assessment	Provisions for the STS
			Decide capability • The operator shall have a documented de-confliction scheme, that explains which tools or methods will be used for detection and what the criteria will be applied for the decision to avoid incoming traffic. In cases where the remote PIC relies on detection by VOs, the use of phraseology shall be described and understood. • The remote PIC shall initiate a rapid descent if traffic crosses the 3NM boundary and operates at less than 1000ft AGL. The VO monitoring traffic shall use a predefined phrase such as, 'DESCEND! DESCEND! DESCEND!'…	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§ 5.1.3-"Contingency procedures" that: Contingency procedures shall at least contain: … (5) De-confliction scheme, i.e. the criteria that will be applied for the decision to avoid incoming traffic. In cases where the detection is performed by Visual Observers (VOs), the use of clear phraseology shall be established.
			Command 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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Tactical mitigation that: 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.
			Execute • Avoidance manoeuvres may rely on performing a rapid descent to a safe altitude, or an immediate rapid landing (when a cleared landing space can be verified prior to descent). • The aircraft should have the performance capability to descend safely from its operating altitude to the 'safe altitude' in less than a minute or have a descend rate of ≥ 500 feet per minute.	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§ 5.1.3-"Contingency procedures" that: Contingency procedures shall at least contain: … (6) Avoidance procedures Avoidance manoeuvres may rely on performing a rapid descent to a safe altitude, or an immediate rapid landing (when a cleared landing space can be verified prior to descent). It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / General that: The UA shall have the performance capability to descend safely from its operating altitude to a 'safe altitude' in less than a minute or have a descend rate of ≥ 2.5 m/s (500 fpm) as defined in §5.1.3-"Contingency procedures"

Tactical mitigations for the Final ARC		level of robustness	Criteria in Risk Assessment	Provisions for the STS
			Feedback loop • Where an electronic means is used to assist the PIC and/or VOs of being aware of UA position, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Command, Control links (C2) and communication that: • Communication between remote pilot and VO shall allow for the remote pilot to manoeuvre the UA with sufficient time to yield right-of-way in accordance with the following provisions: ○ The unmanned aircraft must yield the right of way to all aircraft and airborne vehicles. ○ No person may operate an unmanned aircraft so close to another aircraft so as to create a collision hazard. It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Tactical mitigation that: • Where an electronic means is used to assist the remote pilot and/or VOs in being aware of UA position in relation to potential "airspace intruders", the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.
	LEVEL of ASSURANCE		The applicant declares that the required level of integrity has been achieved (Supporting evidences may or may not be available).	These informations shall be gathered in applicant CONOPS

Table 10: Compliance check of STS proposed provisions against SORA criteria for Tactical Mitigations used for final ARC (source: based on SORA)

7.2.6.4 Operational Safety Objectives

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the STS

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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / Operator competency that:
				• The operator shall have:
				  ○ knowledge of the UAS being used, and
				  ○ relevant procedures including at least the following as a minimum: operational procedures (eg.checklists), maintenance, training, responsibilities, and duties
				• Aforementioned aspect should be addressed in the Concept of Operations (CONOPS)
				See also:
				§5-"APPENDIX A: OPERATIONS MANUAL"
				§6-"APPENDIX B: TRAINING"

	LEVEL of ASSURANCE		The elements requested for the level of integrity are addressed in the CONOPS.	No explicit "level of assurance" is indicated for the level of knowledge of the operator in the used UAS (and supporting means), so it is assumed that it is self-evaluated by the operator. Regarding operating procedures (included in the SOPs) and maintenance procedures, these should at least documented (as indicated in the corresponding OSOs) and, consequently, should be available for the competent authority if required.

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the STS
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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / UAS maintenance that: • The UAS maintenance instructions shall be defined, documented and cover the UAS manufacturer instructions and requirements when applicable. • The maintenance staff shall be competent and shall have received an authorisation to carry out maintenance. • The maintenance staff shall use the UAS maintenance instructions while performing maintenance.
	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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / UAS maintenance that: • The maintenance instructions shall be documented. • The maintenance conducted on the UAS shall be recorded in a maintenance log system. • A list of maintenance staff authorised to carry out maintenance is established and kept up to date. • A record of all relevant qualifications, experience and/or trainings completed by the maintenance staff established and kept up to date. The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative.
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.:*	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Command, Control links (C2) and communication that: • The UAS shall comply with the appropriate requirements for radio equipment and the use of RF spectrum. • Protection mechanisms against interference shall be used, especially if unlicensed bands (e.g. ISM) are used for C2 Link

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the STS**
			○ *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 strength and receiving an alert from the UAS HMI if the signal becomes too low.*	(mechanisms like Frequency Hopping Spread Spectrum – FHSS, technology or frequency de-confliction by procedure) It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / General that: • Means to monitor critical parameters for a safe flight shall be available, in particular: … ○ status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS …) means shall be provided to monitor the adequate performance and triggering an alert if level is becoming too low.
	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*	These informations shall be gathered in applicant CONOPS
OSO #07 Inspection of the UAS (product inspection) to ensure consistency to the ConOps	LEVEL of INTEGRITY	Low	The remote crew performs pre-flight inspection to ensure the UAS is in a condition for safe operation and conforms to the approved concept of operations.	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§5.1.2 -"Normal procedures" that: (1) Pre-flight inspection procedures, which shall be: i. performed by the remote flight crew to ensure the UAS is in a condition for safe operation and conforms to the concept of operations (CONOPS), and
	LEVEL of ASSURANCE		• Criterion #1 (Procedure): ○ Product inspection is documented and accounts for the manufacturer's recommendations if available. • Criterion #2 (Training): The maintenance team is self-trained to maintenance procedures.	It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§5.1.2 -"Normal procedures" that: (2) Pre-flight inspection procedures, which shall be: … ii. documented (at least as part of the manufacturer's instructions and requirements)

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the STS
				It is written in §6-"APPENDIX B: TRAINING"/§ 6.2-"Maintenance staff" that: Maintenance personnel shall be trained to the documented maintenance procedures. Evidence of training shall be presented for inspection upon request from the competent authority or authorised representative. The operator may declare the maintenance team has received training to documented maintenance procedures; however, evidence of this training shall be made available upon request from the competent authority or authorised representative.
Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)	LEVEL of INTEGRITY	Medium	• Criterion #1 (Procedure definition): ○ Operational procedures[1] 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. ○ 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	• Criterion #1 (Procedure definition): ○ It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§5.1.1 -"General" that: Operational procedures 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. The limitations of the external systems used to support UAS safe operations are defined in an Operation Manual.

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the STS
			adherence to): Operational procedures involve the remote pilot to take manual control(1) when the UAS is usually automatically controlled. • Criterion #3 (Consideration of Potential Human Error): Operational procedures take considerations of human errors. At a minimum, Operational procedures provide: ○ a clear distribution and assignment of tasks ○ an internal checklist to ensure staff are performing their assigned tasks.	• Criterion #3 (Consideration of Potential Human Error): ○ It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"15"/§5.1.1 -"General" that: Operational procedures shall consider human errors and shall include at least: ▪ a clear distribution and assignment of tasks, ▪ an internal checklist to check that staff is properly performing assigned tasks adequately
	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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / UAS operations that: • The following shall be defined and documented in an Operations Manual: ○ Operational procedures and Emergency Response Plan (ERP) ○ Limitations of the external systems supporting UAS for safe operations. ○ Environmental conditions required for a safe operation • Operational procedures shall be validated against standards recognised by the competent authority and/or in accordance with a means of compliance acceptable to that authority. • The adequacy of the contingency and emergency procedures shall be proved through: ○ Dedicated flight tests, or ○ Simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results, or ○ Any other means acceptable to the competent authority.
Remote crew training (OSO #09, OSO #15	LEVEL of INTEGRITY	Low	The competency-based theoretical and practical training ensures knowledge of:	It is written in §6-"APPENDIX B: TRAINING"/§ 6.1-"Remote crew" / §6.1.1-"Remote flight crew training and qualification" that:

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the STS**
and OSO #22)			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.	The operator shall ensure the entire remote crew (i.e. any person involved in the operation) are provided with competency-based theoretical and practical training specific to their duties that consists of the following elements: • Basic competencies from the competency framework necessary to ensure safe flight and within the conditions of this standard scenario: o UAS regulation o UAS airspace operating principles o Airmanship and aviation safety o Human performance limitations o Meteorology o Navigation/Charts o UA knowledge o Operating procedures … And shall be adequate for the operation • Familiarization with CAT B (Specific Category).
	LEVEL of ASSURANCE		Training is self-declared (with evidence available)	It is written in §6-“APPENDIX B: TRAINING”/§ 6.1-“Remote crew” / §6.1.1-“Remote flight crew training and qualification” that: Evidence of training shall 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	LEVEL of INTEGRITY	Low	i. 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. ii. 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).	N/A as operations are planned in sparsely populated areas

Operational Safety Objectives (OSOs)		SAIL II expected level of robustness	Criteria in SORA for SAIL II	Provisions for the STS
operation			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 probable1 failure2 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.	
	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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / External services that: • The applicant shall 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 applicant shall declare that this adequate level of performance is achieved. • Roles and responsibilities between the applicant and the external service provider shall be defined.
	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)	These informations shall be gathered in applicant CONOPS

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the STS**

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.
				It is written in:
				• §6-“APPENDIX B: TRAINING”/§ 6.1-“Remote crew”/§ 6.1.1-“Remote flight crew training and qualification” that:
				  • The operator shall ensure the entire remote crew (i.e. any person involved in the operation) are provided with competency-based theoretical and practical training specific to their duties that consists of the following elements:
				  Basic competencies from the competency framework necessary to ensure safe flight:
				  ...
				  ○ assignment of tasks to the crew,
				  ○ establishment of step-by-step communications
				  ○ Coordination and handover
				• §6-“APPENDIX B: TRAINING”/§ 6.1-“Remote crew”/§6.1.4 -“Multi-crew cooperation (MCC)” that:
				  (1) include in the SOP (section 4.1.2) procedures to ensure a coordination between the remote flight crew members with robust and effective communication channels. Those procedures should cover at minimum:
				  i. assignment of tasks to the remote flight crew members,
				  ii. establishment of a step-by-step communication.
				  (2) ensure that the training of remote flight crew (§6.1.4-“Multi-crew cooperation (MCC)”) covers MCC.

	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)”

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the STS**
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.	It is written in §6-"APPENDIX B: TRAINING"/§ 6.1-"Remote crew"/§6.1.5 -"Remote crew fit to operate" that The UAS operator shall establish a policy for remote flight crew declaration of being fit to operate before conducting any operation.
	LEVEL of ASSURANCE		The remote crew declare they are fit to operate before conducting any operation based on the policy defined by the applicant.	It is written in §6-"APPENDIX B: TRAINING"/§ 6.1-"Remote crew"/§6.1.5 -"Remote crew fit to operate" that Before conducting any operation, the remote crew shall declare they are fit to operate based on the policy defined by the UAS operator.
OSO #20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission	LEVEL of INTEGRITY	Low	The UAS information and control interfaces are clearly and succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew error that could adversely affect the safety of the operation. *Comments / Notes:* *If an electronic means is used to support potential Visual Observers in their role to maintain awareness of the position of the unmanned aircraft, its HMI:* • *is sufficient to allow the Visual Observers to determine the position UA during operation;* • *does not degrade the Visual Observer's ability to:* ○ *scan the airspace where the unmanned aircraft is operating for any potential collision hazard; and* ○ *maintain effective communication with the remote pilot at all times.*	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Human machine Interface that: • The UAS information and control interfaces shall be clearly and succinctly presented and shall not confuse, cause unreasonable fatigue, or contribute to remote flight crew error that could adversely affect the safety of the operation. • If an electronic means is used to support Visual Observers in their role to maintain awareness of the position of the unmanned aircraft, its HMI shall: ○ be sufficient to allow the Visual Observers to determine the position of the UA during operation; ○ not degrade the Visual Observer's ability to: ▪ perform unaided visual scanning of the airspace where the UA is operating for any potential collision hazard; and ▪ maintain effective communication with the remote pilot at all times.
	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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Human machine Interface that: The applicant shall conduct an evaluation of the UAS considering and addressing human factors to determine the HMI is appropriate for the mission.

Operational Safety Objectives (OSOs)		**SAIL II expected level of robustness**	**Criteria in SORA for SAIL II**	**Provisions for the STS**
OSO #23 Environmental conditions for safe operations defined, measurable and adhered to	LEVEL of INTEGRITY	Low	• Criteria #1 (Definition) Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document. • Criteria #2 (Procedures) Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple record system. • Criterion #3 (Training): Training covers assessment of meteorological conditions	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 4. Operator provisions / UAS operations that: • The following shall be defined and documented in an Operations Manual: … o Environmental conditions required for a safe operation It is written in §5-"APPENDIX A: OPERATIONS MANUAL"/§ 5.1-"Operational procedures"/§ 5.1.1-"General" that: Operational procedures appropriate for the specificities of the operation to be approved are defined and cover at least the following elements: … • Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation),
	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): As "environmental conditions" are required to be included as part of the manufacturer's documentation delivered with the UAS and supporting means, and this criterion for assurance is complied with. • 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 11: Compliance check of STS proposed provisions against SORA criteria for OSOs (source: based on SORA)

7.2.6.5 Adjacent Area/Airspace Consideration

Mitigations used for containment objectives		level of robustness	Criteria in SORA	Provisions for the STS
	LEVEL of INTEGRITY	Med	No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Containment that: To ensure a safety recovery from a technical issue involving the UAS or external system supporting the operation, the operator shall ensure: • No probable failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume. • It shall be 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 minimally include: ○ design and installation features (independence, separation and redundancy); ○ particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Containment that: • A design and installation appraisal highlighting shall be made available and shall minimally include: ○ design and installation features (independence, separation and redundancy); ○ particular risks (e.g. hail, ice, snow, electro-magnetic interference…) relevant to the ConOps.
	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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Containment that: 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.
	LEVEL of ASSURANC		Compliance with the requirements above shall be substantiated by analysis and/or test data with supporting evidence.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6.

Mitigations used for containment objectives		**level of robustness**	**Criteria in SORA**	**Provisions for the STS**
	E			Technical provisions / Containment that: Following additional requirements shall apply if adjacent area/airspace are gathering of people or ARC-d: • … • Compliance with the requirements above shall be substantiated by analysis and/or test data with supporting evidence.
	LEVEL of INTEGRITY		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.	It is written in §2-"STS characterisation and provisions" / Table 1: Summary of main limitations and provisions for JARUS-STS-01 / 6. Technical provisions / Containment that: 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.
	LEVEL of ASSURANCE			Level of assurance required by adequate standards

Table 12: Compliance check of STS proposed provisions against SORA criteria for Mitigations used for Containment objectives (source: based on SORA)

7.2.6.6 Conclusion

From the compliance check shown in sections §7.2.6.1, §7.2.6.2, §7.2.6.3, §7.2.6.4, § 7.2.6.5, it can be concluded that the provisions proposed for the STS are well aligned with the corresponding criteria. In fact, to ensure that alignment, a significant number of those criteria were incorporated.