SORA-riskianalyysi

- Yleiskatsaus menetelmästä
- Liitteiden tarkoitukset
- Käytännön esimerkkejä

Specific-kategorian alaraja

- Heti kun toiminta ylittää minkä vain Open-kategorian rajan, siirrytään Specific-kategoriaan
- Esimerkkejä rajojen ylityksistä:
  - BVLOS-lennot
  - Dronen paino yli 25 kg
  - Lennot kaupunkialueilla yli 4 kg dronella
  - Lennot lähellä lentoasemaa tai rajoitusalueilla
  - Lennot korkeammalla kuin 120 m
  - Esineiden pudottaminen dronesta

Specific-kategorian yläraja

Toiminta Certified-kategoriassa jos:

- Dronella kuljetetaan ihmisiä
- Dronella kuljetetaan vaarallisia aineita
- Lennetään väkijoukon päällä yli 3 metrin kokoluokan dronella
- SORA-riskiarvioinnin lopputulos ylittää menetelmän sallimat rajat

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JARUS SORA -paketti

JARUS Joint Authorities for Rulemaking on Unmanned Systems

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JAR doc 06 SORA (package)

Doc Title
Executive Summary
JARUS guidelines on Specific Operations Risk Assessment (SORA)
JARUS guidelines on SORA **Annex A** - Collecting and presenting system and operation information for a specific UAS operation
JARUS guidelines on SORA **Annex B** - Integrity and assurance levels for the mitigations used to reduce the intrinsic Ground Risk Classes
JARUS guidelines on SORA **Annex C** - Strategic Mitigation Collision Risk Assessment
JARUS guidelines on SORA **Annex D** - Tactical Mitigations Collision Risk Assessment
JARUS guidelines on SORA **Annex E** - Integrity and assurance levels for the Operational Safety Objectives (OSO)
JARUS guidelines on SORA **Annex I** - Glossary of Terms

EASA SORA – virallinen versio Euroopassa

10 OCT 2019

ED Decision 2019/021/R

AMC and GM to Commission Implementing Regulation (EU) No 2019/947

Agency Decision Category: Rulemaking activities

issuing Acceptable Means of Compliance and Guidance Material to Commission Implementing Regulation (EU) No 2019/947 'Rules and procedures for the operation of unmanned aircraft'

DOWNLOADS

Explanatory note to ED Decision 2019/021/R

- ED Decision 2019/021/R
- AMC & GM to Commission Implementing Regulation (EU) 2019/947 — Issue 1
- AMC & GM to Part-UAS — Issue 1

Ensimmäinen EASAn julkaisema PDRA lupatyyppi

Annex II to ED Decision 2019/021/R

AMC2 Article 11 Rules for conducting an operational risk assessment

PREDEFINED RISK ASSESSMENT PDRA-01 Version 1.0

EDITION September 2019

(a) Scope

This PDRA is the result of applying the methodology described in AMC1 to Article 11 of the UAS Regulation to UAS operations performed in the 'specific' category with the following main

ter/area or
ical kinetic

- Kopio JARUS STS-01 luvasta pienillä muutoksilla
- JARUS tehnyt myös toisen lupatyypin BVLOS toimintaan STS-02

(4) less than 150 m (500 ft) above the overflown surface (or any other altitude reference defined by the state); and

(5) in uncontrolled airspace.

EASA PDRA-01

PDRA characterisation and provisions	
1. Operational characterisation (scope and limitations)	
Level of human intervention	1.1 No autonomous operations: the remote pilot should have the ability to control the UA, except in case of a lost link. 1.2 The remote pilot should only operate one UA at a time. 1.3 The remote pilot should not operate from a moving vehicle. 1.4 Handover between RPSs should not be performed.
UA range limit	1.5 Launch/recovery: VLOS distance from the remote pilot 1.6 In flight: 1.6.1 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. *Note: The remote pilot's workload should be adequate to allow him or her to continuously scan the airspace.* 1.6.2 If VOs are used: the range is not limited as long as the UA is not operated at more than 1 km (unless a different distance is defined by the competent authority) from the VO who is nearest to the UA.
Overflown areas	1.7 Sparsely populated areas.
UA limitations	1.8 Maximum characteristic dimension (e.g. wingspan, rotor diameter/area or maximum distance between rotors in the case of a multirotor): 3 m 1.9 Typical kinetic energy (as defined in paragraph 2.3.1(k) of AMC1 to Article 11 of the UAS Regulation up to 34 kJ

EASA PDRA-01

<table>
<tr><td>Flight height limit</td><td colspan="5">1.10 The maximum height of the operational volume should not be greater than 150 m (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 this table).</td></tr>
<tr><td>Airspace</td><td colspan="5">1.11 Operated:
1.11.1 in uncontrolled airspace (Class F or G) (corresponding to an air risk that can be classified as ARC-b); or
1.11.2 in a segregated area (corresponding to an air risk that can be classified as ARC-a); or
1.11.3 as otherwise established by the Member States in accordance with Article 15 (with an associated air risk that can be classified as not higher than ARC-b)</td></tr>
<tr><td>Visibility</td><td colspan="5">1.12 The UA should be operated in an area where the minimum flight visibility is more than 5 km.
Note: This flight visibility should be understood as the distance that an aircraft can be visually detected by the remote crew.</td></tr>
<tr><td>Others</td><td colspan="5">1.13 The UA should not be used to drop material or carry dangerous goods, except for dropping items in connection with agricultural, horticultural or forestry activities in which the carriage of the items does not contravene any other applicable regulations.</td></tr>
<tr><td colspan="6">**2. Operational risk classification (according to the classification defined in AMC1 to Article 11 of the UAS Regulation)**</td></tr>
<tr><td>Final GRC</td><td>**3**</td><td>Final ARC</td><td>**ARC-b**</td><td>SAIL</td><td>**II**</td></tr>
</table>

EASA PDRA-01

3. Operational mitigations	
Operational volume (see Figure PDRA-01.1)	3.1 To determine the operational volume, the applicant should consider the position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time). 3.2 In particular, the accuracy of the navigation solution, the flight technical error of the UAS and the path definition error (e.g. map error) and latencies should be considered and addressed in this determination. 3.3 If the UA leaves the operational volume, emergency procedures should be activated immediately.
Ground risk	3.4 A ground risk buffer should be established to protect third parties on the ground outside the operational volume. 3.4.1 The minimum criterion should be the use of the '1:1 rule' (e.g. if the UA is planned to operate at a height of 150 m, the ground risk buffer should at least be 150 m). 3.5 The operational volume and the ground risk buffer should be all contained in a sparsely populated environment. 3.6 The applicant should evaluate the area of operations typically by means of an on-site inspection or appraisal, and should be able to justify a lower density of people at risk.

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Air risk	3.7 An air risk buffer should be defined. 3.8 This air risk buffer should be contained in the F or G airspace class (uncontrolled airspace) over sparsely populated areas and in UAS geographical zones defined by MSs where the probability of encounter with manned aircraft and other airspace users is not low. 3.9 The operational volume should be outside any geographical zone corresponding to a flight restriction zone of a protected aerodrome or of any other type, as defined by the responsible authority, unless the UAS operator is in receipt of the appropriate permission. 3.10 Prior to flight, the proximity of the planned operation to manned aircraft activity should be assessed.
VOs	3.11 The remote pilot should determine the correct placement and number of VOs along the intended flight path. Prior to each flight, the UAS operator should check: 3.11.1 the compliance between the visibility and planned range for VOs; 3.11.2 the presence of potential terrain obstructions for VOs; and 3.11.3 that there are no gaps between the zones covered by each of the VOs. 3.12 The VO(s) necessary to safely conduct the operation should be in place during flight operations. Note: The remote pilot may perform the visual scan of the airspace instead of a VO provided that the workload is adequate to perform his or her duties as the remote pilot.

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4. Operator provisions	
Operator	4.1 The UAS operator should: 4.1.1 have knowledge of the UAS being used; and 4.1.2 develop relevant procedures including at least the following as a minimum: operational procedures (e.g. checklists), maintenance, training, responsibilities, and duties. 4.2 The aforementioned aspects should be addressed in the ConOps (see Annex A to AMC1 to Article 11 of the UAS Regulation).

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UAS operations	4.3 The UAS operator should develop an OM (for the template, refer to GM1 UAS.SPEC.030(3)(e)). 4.4 The operational procedures should be validated against standards recognised by the competent authority and/or in accordance with a means of compliance acceptable to that authority. 4.5 The adequacy of the contingency and emergency procedures should be proved through: 4.5.1 dedicated flight tests; or 4.5.2 simulations, provided that the representativeness of the simulation means is proven for the intended purpose with positive results; or 4.5.3 any other means acceptable to the competent authority. 4.6 The UAS operator should develop an ERP (see GM2 UAS.SPEC.030(3)(e)) 4.7 The remote crew should be competent and be authorised by the UAS operator to carry out the intended operations. 4.8 A list of the remote crew members authorised to carry out UAS operations is established and kept up to date. 4.9 A record of all the relevant qualifications, experience and/or training completed by the remote crew is established and kept up to date. 4.10 The applicant should have a policy that defines how the remote crew can declare themselves fit to operate before conducting any operation.

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UAS maintenance	4.11 The UAS maintenance instructions should be defined by the UAS operator, documented and cover at least the UAS manufacturer's instructions and requirements when applicable. 4.12 The maintenance staff should be competent and should have received an authorisation from the UAS operator to carry out maintenance. 4.13 The maintenance staff should use the UAS maintenance instructions while performing maintenance. 4.14 The maintenance instructions should be documented. 4.15 The maintenance conducted on the UAS should be recorded in a maintenance log system. 4.16 A list of the maintenance staff authorised to carry out maintenance should be established and kept up to date. 4.17 A record of all the relevant qualifications, experience and/or training completed by the maintenance staff should be established and kept up to date. 4.18 The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative.
External services	4.19 The applicant should ensure that the level of performance for any externally provided service necessary for the safety of the flight is adequate for the intended operation. The applicant should declare that this adequate level of performance is achieved. 4.20 The roles and responsibilities between the applicant and the external service provider should be defined.

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6. Technical provisions	
General	6.1 Means to monitor critical parameters for a safe flight should be available, in particular the: 6.1.1 UA position, height or altitude, ground speed or airspeed, attitude and trajectory; 6.1.2 UAS energy status (fuel, battery charge, etc.); and the 6.1.3 status of critical functions and systems; as a minimum, for services based on RF signals (e.g. C2 Link, GNSS, etc.), means should be provided to monitor the adequate performance and trigger an alert if the level becomes too low. 6.2 The UA should have the performance capability to descend safely from its operating altitude to a 'safe altitude' in less than a minute, or have a descent rate of at least 2.5 m/s (500 fpm).
HMI	6.3 The UAS information and control interfaces should be clearly and succinctly presented and should not confuse, cause unreasonable fatigue, or contribute to causing any disturbance to the personnel in charge of duties essential to the UAS operation such that this could adversely affect the safety of the operation. 6.4 If an electronic means is used to support VOs in their role of maintaining awareness of the position of the unmanned aircraft, its HMI should: 6.4.1 be sufficiently easy to understand to allow the VOs to determine the position of the UA during the operation; and 6.4.2 not degrade the VOs' ability to: 6.4.2.1 perform unaided visual scanning of the airspace where the UA is operating for any potential collision hazard; and 6.4.2.2 maintain effective communication with the remote pilot at all times. 6.5 The applicant should conduct an evaluation of the UAS considering and addressing human factors to determine whether the HMI is appropriate for the mission.

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EASA PDRA-01

C2 links and communication	6.6 The UAS should comply with the appropriate requirements for radio equipment and the use of the RF spectrum. 6.7 Protection mechanisms against interference should be used, especially if unlicensed bands (e.g. ISM) are used for the C2 Link (mechanisms such as FHSS, technology or frequency de-confliction by procedure). 6.8 Communication between the remote pilot and the VO(s) should allow the remote pilot to manoeuvre the UA with sufficient time to avoid any risk of collision with manned aircraft, in accordance with UAS.SPEC.060(3)(b) of the UAS Regulation.
Tactical mitigation	6.9 The UAS design should be adequate to ensure that the time required between a command given by the remote pilot and the UA executing it does not exceed 5 seconds. 6.10 Where an electronic means is used to assist the remote pilot and/or VOs in being aware of the UA position in relation to potential 'airspace intruders', the information is provided with a latency and an update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.

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Containment	6.11 To ensure a safe recovery from a technical issue involving the UAS or an external system supporting the operation, the UAS operator should ensure: 6.11.1 that no probable failure of the UAS or any external system supporting the operation should lead to operation outside the operational volume. 6.11.2 that it is reasonably expected that a fatality will not occur from any probable failure of the UAS, or any external system supporting the operation. 6.12 The vertical extension of the operational volume should be 150 m above the surface (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.'* 6.13 A design and installation appraisal should be made available and should minimally include: 6.13.1 design and installation features (independence, separation and redundancy); 6.13.2 particular risks (e.g. hail, ice, snow, electro-magnetic interference, etc.) relevant to the ConOps.

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6.14 The following additional provisions should apply if the adjacent area includes an assembly of people or if the adjacent airspace is classified as ARC-d (in accordance with AMC1 to Article 11 of the UAS Regulation):

6.141 The probability of leaving the operational volume should be less than 10-4/FH.

6.14.2 No single failure of the UAS or any external system supporting the operation should lead to operation outside the ground risk buffer.

Note: The term 'failure' needs to be understood as an occurrence, which affects the operation of a component, part, or element such that it can no longer function as intended. Errors may cause failures but are not considered to be failures. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.

6.16.3 SW and AEH whose development error(s) could directly lead to operations outside the ground risk buffer should be developed to an industry standard or methodology recognised as adequate by the competent authority.

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- Koulutusvaatimukset vielä tarkemmin määrittelemättä!

SORA-riskiarviointi - tarpeellisuus

Riskiarviointi tulee tehdä jos

- toimintaa ei pystytä tekemään Avoin-kategoriassa
- erityinen-kategoriassa mikään olemassa oleva PDRA ei sovi toimintaan

SORA-riskiarviointi - sisältö

LIST OF ANNEXES

(available as separate documents)

Päädokumentit

- **CONOPS Annex A**
- JARUS guidelines on Specific Operations Risk Assessment (tunnettu nimellä **SORA main body**)

Lisäksi julkaistu **5 liitettä** (Annex), joita vastaa main bodyssa omat osiot

4 tarkentavaa liitettä vielä julkaisematta

Annex A: ConOps
Annex B: Integrity and assurance levels for the mitigations used to reduce the intrinsic GRC
Annex C: Strategic Mitigations
Annex D: Tactical Mitigations
Annex E: Integrity and assurance levels for the Operational Safety Objectives (OSO)
Annex F: Ground Risk Model
Annex G: Air Risk Model
Annex H: Unmanned Traffic Management (UTM) implications to SORA
Annex I: Glossary
Annex J: Guidance to Regulators, ANSPs, and Other Third Parties

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SORA-riskiarviointi - sisältö

Kaikki dokumentit yhteensä 113 sivua

- Iso kokonaisuus, koska kattaa erittäin suuren määrän vaihtelevia operaatioita.
- Kaikki eivät tarvitse kaikkea sisältöä vaan vain omaa toimintaa koskevan osan.
- *Mutta jos lentää Predatorilla kaupungin yli ja aikoo laskeutua lentoasemalle, voi olettaa lukevansa kaiken läpi useampaan kertaan.*

SORA-menetelmän perusta

Likelihood of Fatal injuries to third parties on ground	=	Likelihood of having UAS operation out-of-control	X	Likelihood of person struck by the UA if the operation is out of control	X	Likelihood that, if struck, person is killed
Likelihood of Fatal injuries to third parties in the air	=	Encounter Rate	X	Likelihood of strategic mitigation failing	X	Likelihood of tactical mitigations failing

SORAn tavoite sama turvallisuustaso kuin miehitetyssä ilmailussa

1 kuolema / miljoona lentotuntia

Perinteinen Bow-tie-malli

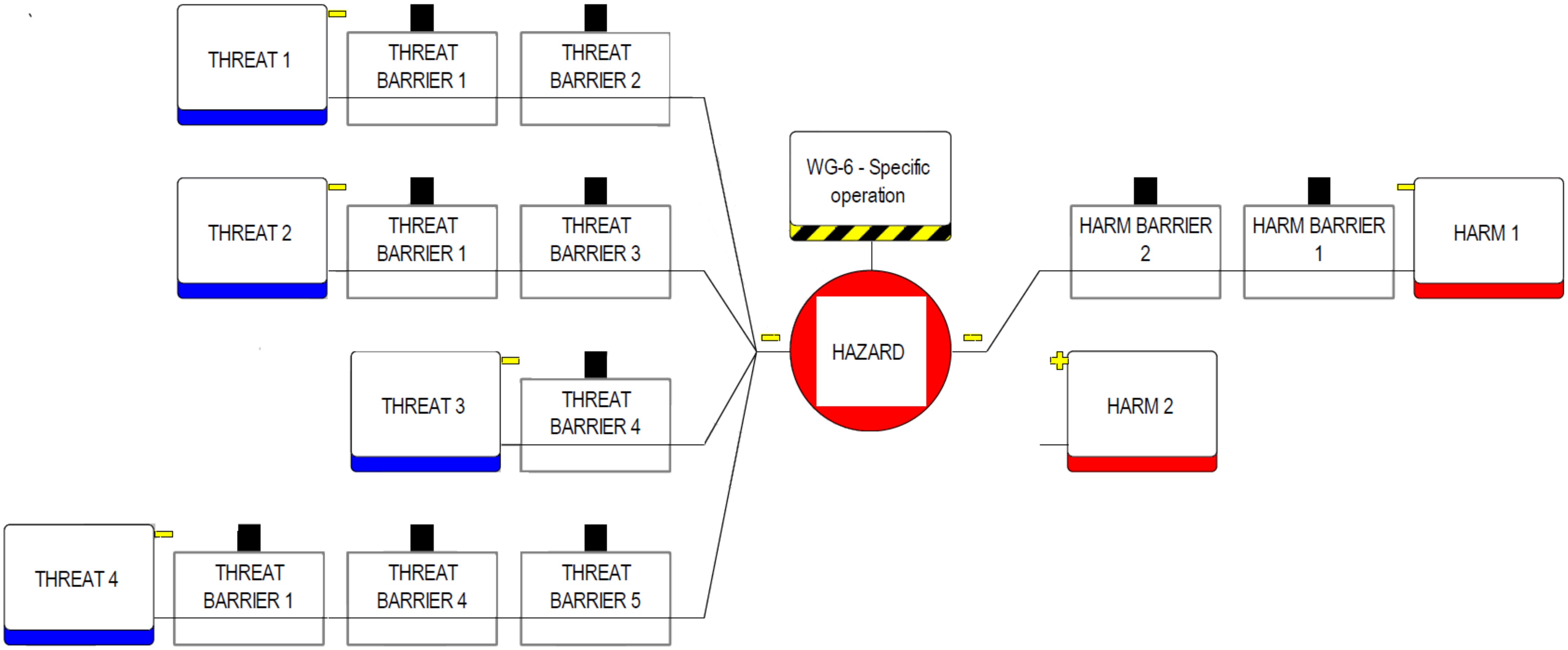
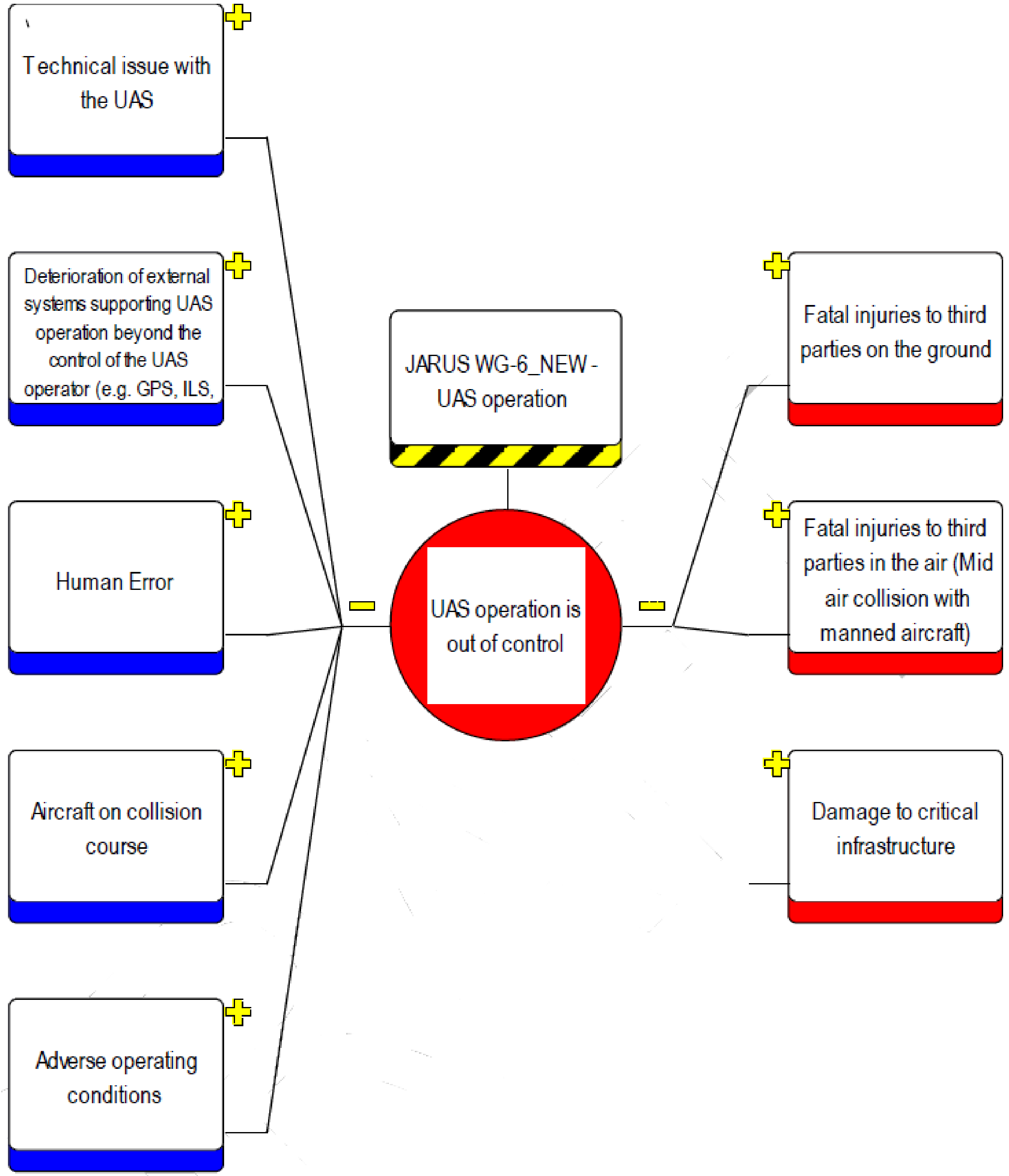


Figure 1 – Bow-tie model

TRAFICOM


Technical issue with the UAS
Deterioration of external systems supporting UAS operation beyond the control of the UAS operator (e.g. GPS, ILS,
Human Error
Aircraft on collision course
Adverse operating conditions
JARUS WG-6_NEW - UAS operation
UAS operation is out of control
Fatal injuries to third parties on the ground
Fatal injuries to third parties in the air (Mid air collision with manned aircraft)
Damage to critical infrastructure

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SORA- termistö

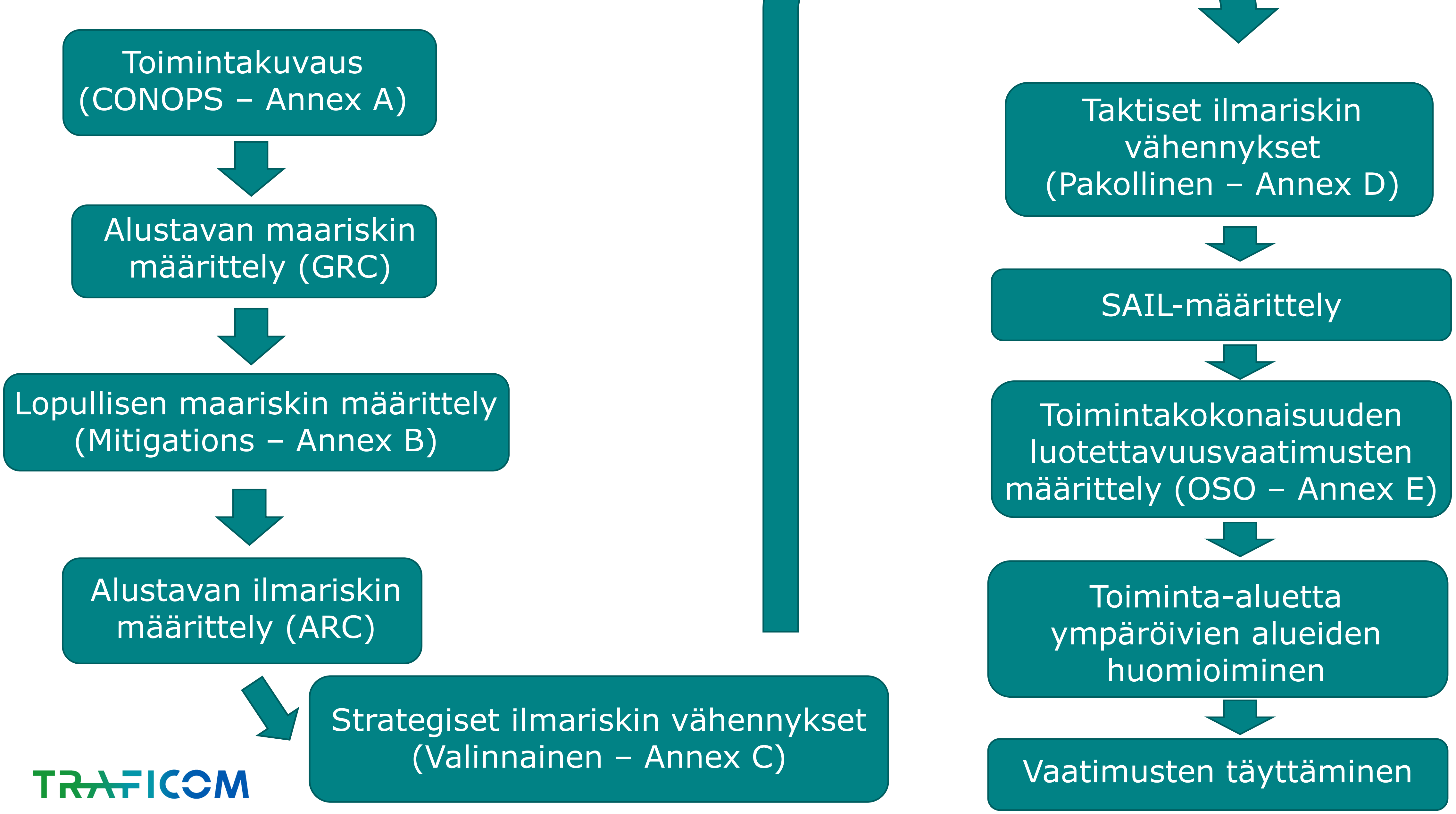
Menetelmää ei ole käännetty vielä suomeksi

Saatavilla vain englanniksi

ANNEX I – Glossary of Terms

Term	Acronym	Definition
Abnormal situation		One in which it is no longer possible to continue the flight using normal procedures but the safety of the aircraft or persons on board or on the ground is not in danger.
Acceptable risk		The level of risk that individuals or groups are willing to accept given the benefits gained. Each organization will have its own acceptable risk level, which is derived from its legal and regulatory compliance responsibilities, its threat profile, and its business/organizational drivers and impacts.
Accident		An unplanned event or series of events that results in death, injury, or damage to, or loss of, equipment or property.
Adequate		What is necessary, desirable or sufficient for a specific requirement.
Aircraft operating manual*		A manual, acceptable to the State of the Operator, containing normal, abnormal and emergency procedures, checklists, limitations, performance information, details of the aircraft systems and other material relevant to the operation of the aircraft. **Note: The aircraft operating manual is part of the operations manual.**
Aircraft*		Any machine that can derive support in the atmosphere from the reactions of the air other than the reaction of the air against the earth's surface.
Airframe		The fuselage, booms, nacelles, cowlings, fairings, airfoil surfaces (including rotors but excluding propellers and rotating airfoils of engines), and landing gear of an aircraft and their accessories and controls.
Airport Environment		Airport environment is generally defined as; a) Class A, B, C, D, or E controlled airspaces which touch the surface with an

SORA-prosessi



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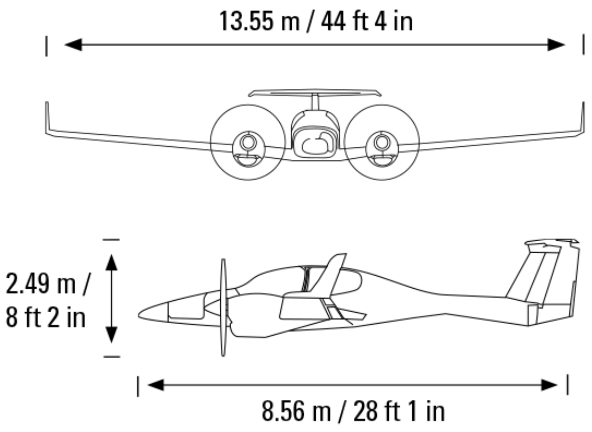
Annex A - CONOPS

Toimintakuvaus CONOPS – Annex A

CONOPS – Mitä tehdään? Millä? Missä? Miten? Kuka?

(voi olla myös operations manual -muodossa)

- Toimijoiden tulee antaa toimintakuvauksessa tarvittavat tiedot operaatiosta SORA riskiarviointia varten
- Osa tiedoista tarvitaan drone valmistajilta
- Jos riskiarvioinnin aikana huomataan ettei pystytä täyttämään riskiä vastaavia vaatimuksia voidaan palata muokkaamaan toiminnan suunnittelua



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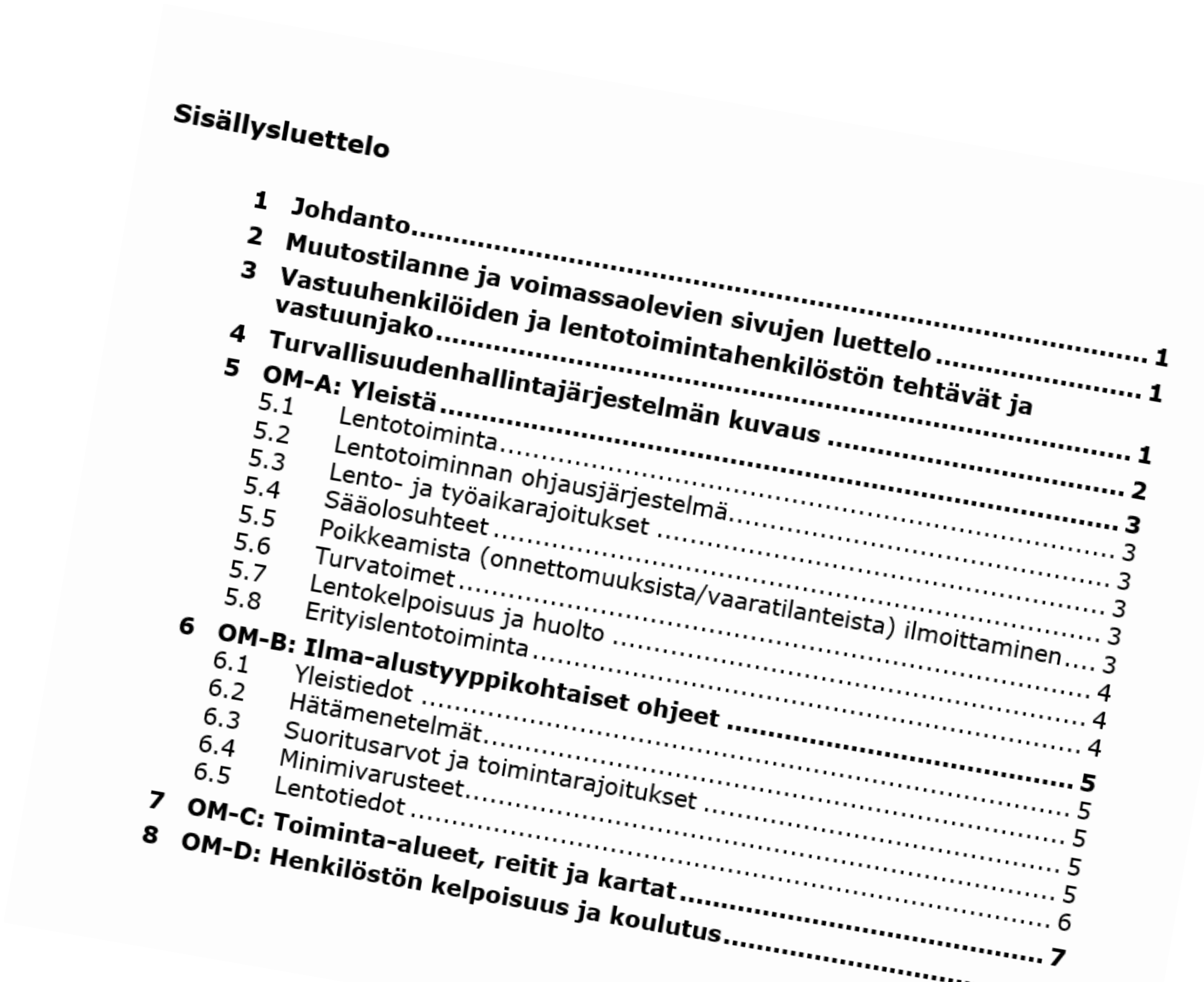
Annex A – 1 Operations

This section covers 5 main points:

1) Definitions
2) Organisation overview
3) Operations
4) Training
5) References



Sisällysluettelo

1 Johdanto 1
2 Muutostilanne ja voimassaolevien sivujen luettelo 1
3 Vastuuhenkilöiden ja lentotoimintahenkilöstön tehtävät ja vastuunjako 1
4 Turvallisuudenhallintajärjestelmän kuvaus 2
5 OM-A: Yleistä 3
5.1 Lentotoiminta 3
5.2 Lentotoiminnan ohjausjärjestelmä 3
5.3 Lento- ja työaikarajoitukset 3
5.4 Sääolosuhteet 3
5.5 Poikkeamista (onnettomuuksista/vaaratilanteista) ilmoittaminen 3
5.6 Turvatoimet 4
5.7 Lentokelpoisuus ja huolto 4
5.8 Erityislentotoiminta 4
6 OM-B: Ilma-alustyyppikohtaiset ohjeet 5
6.1 Yleistiedot 5
6.2 Hätämenetelmät 5
6.3 Suoritusarvot ja toimintarajoitukset 5
6.4 Minimivarusteet 5
6.5 Lentotiedot 6
7 OM-C: Toiminta-alueet, reitit ja kartat 7
8 OM-D: Henkilöstön kelpoisuus ja koulutus 7

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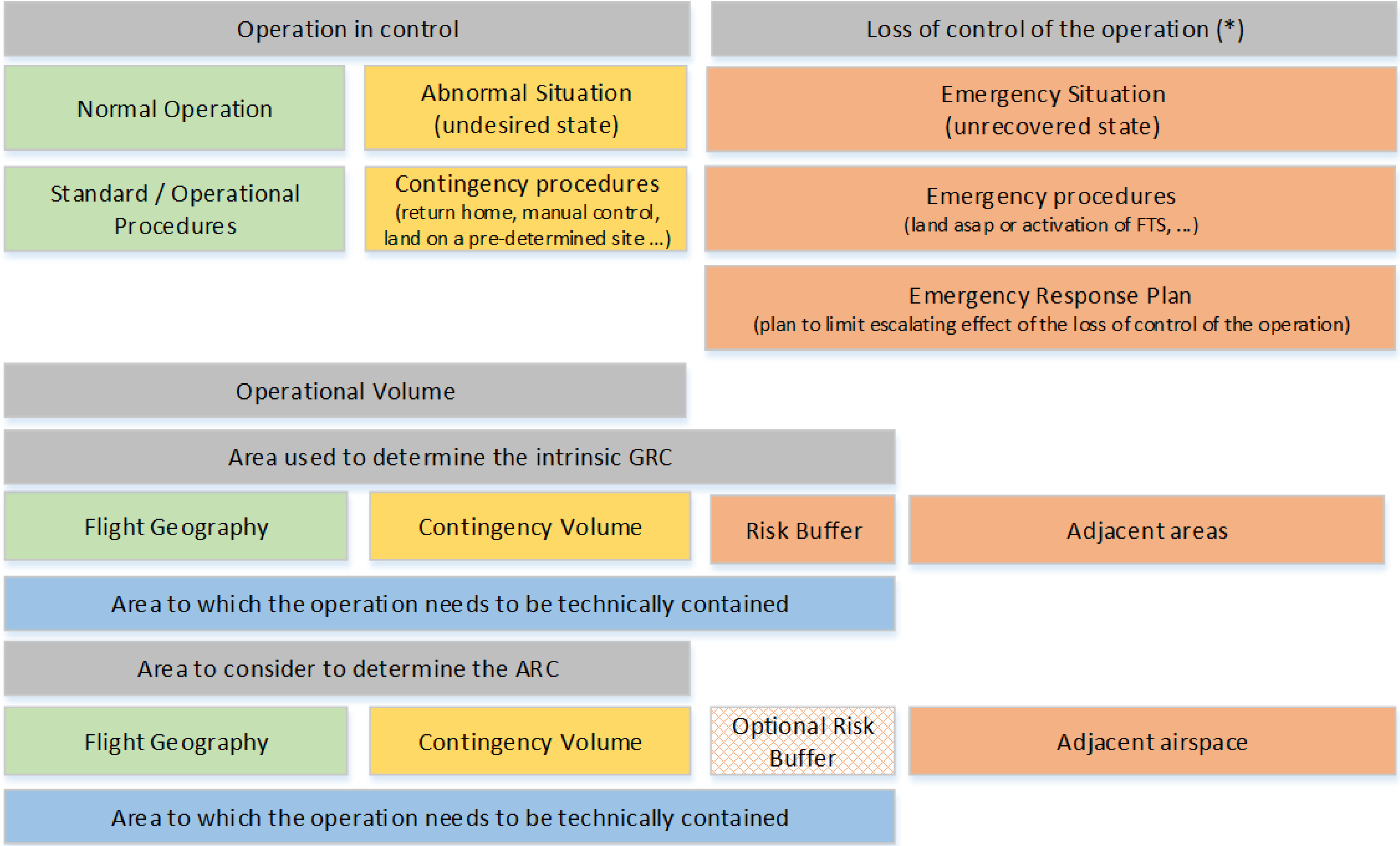
Annex A – 2 Technical

This section covers 10 main points:

1) Definitions
2) UAS description
3) UAS Control segment
4) Geo – fencing
5) Ground Support Equipment (GSE) segment
6) Command and Control Link (C2 Link) segment
7) C2 Link degradation
8) C2 Link Lost
9) Safety features
10) References

SORA - semantic model



(*) The Loss of control of operation corresponds to situations:

- where the outcome of the situation highly relies on providence; or
- which could not be handled by a contingency procedure; or
- when there is grave and imminent danger of fatalities.

Toiminta-alueen määrittely

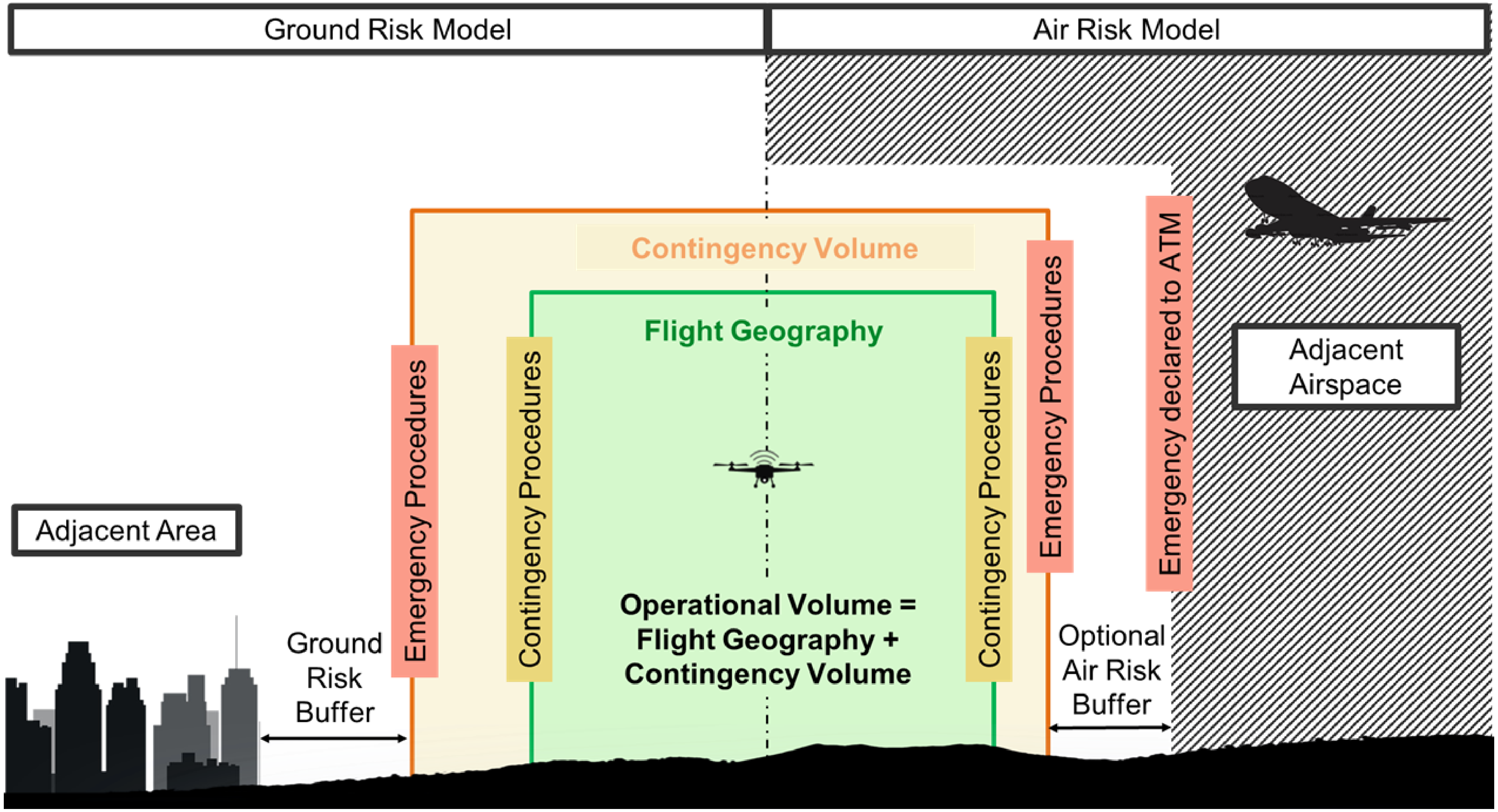
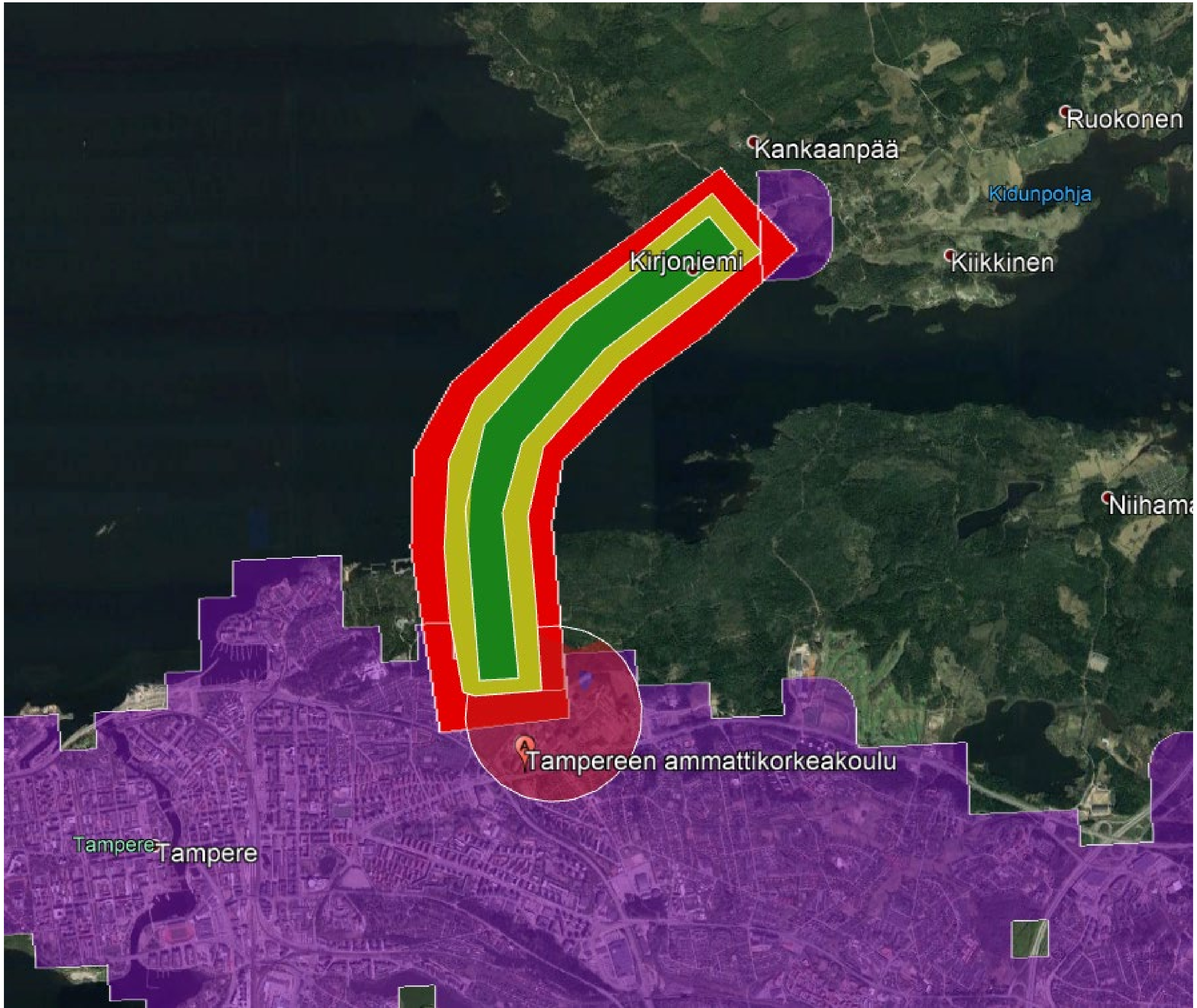


Figure 2 – Graphical Representation of SORA Semantic Model

Toiminta-alueen määrittely



Main body

Intrinsic Ground Risk Determination

Alustavan maariskin määrittely

- SORA riskiarviossa olennaisessa osassa on alustavan ilma- ja maariskin määrittäminen operaatiolle
- <u>*Tavoite on määritellä huonoimman mahdollisen tilanteen seuraukset*</u>

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				
BVLOS over gathering of people	8			

Table 2 – Intrinsic Ground Risk Classes (GRC) Determination

(k) When evaluating the typical kinetic energy expected for a given operation, the applicant should generally use airspeed, in particular V_{cruise} for fixed-wing aircraft and the terminal velocity for other aircraft. Specific designs (e.g. gyrocopters) might need additional considerations. Guidance useful in determining the terminal velocity can be found at https://www.grc.nasa.gov/WWW/K-12/airplane/termv.html

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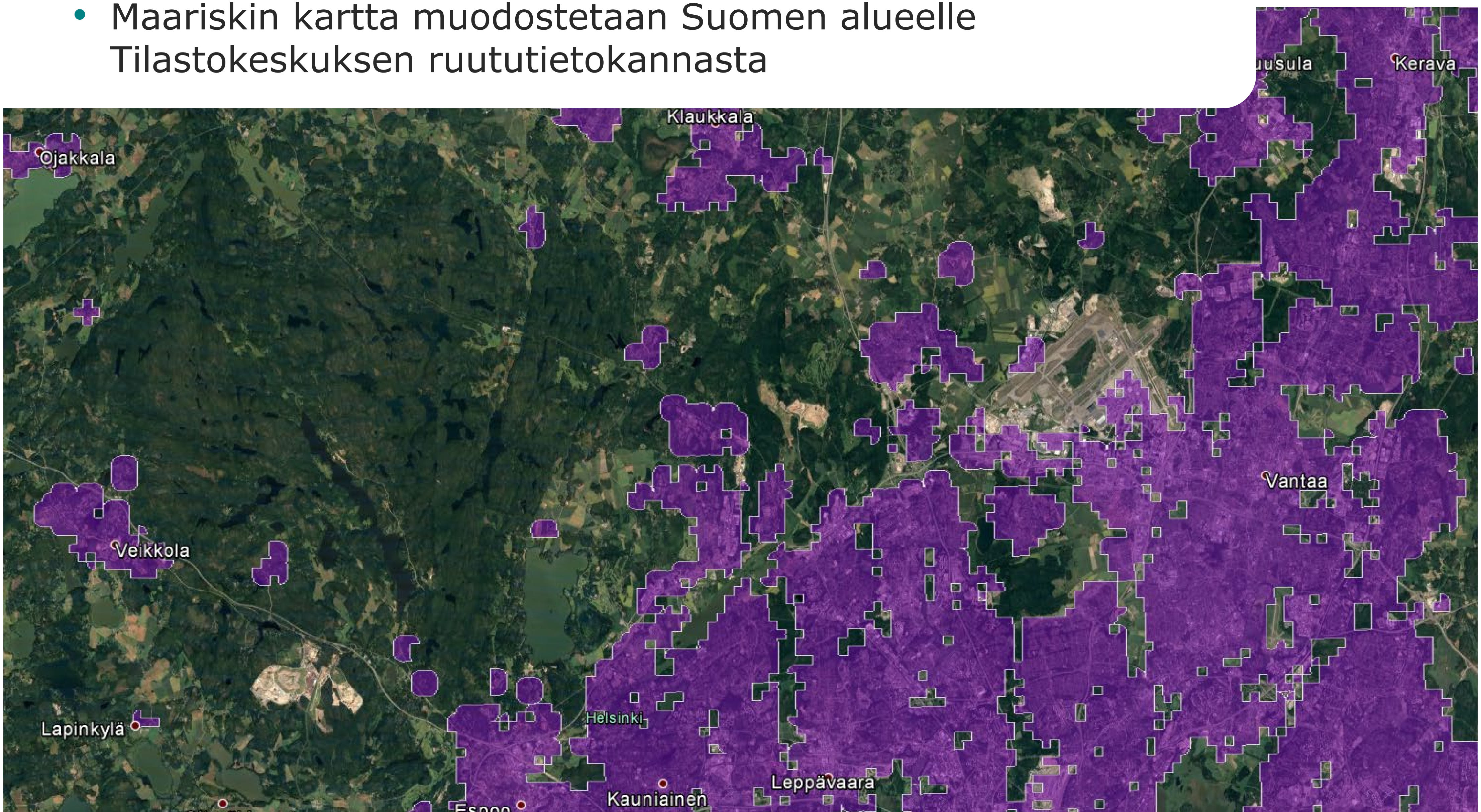
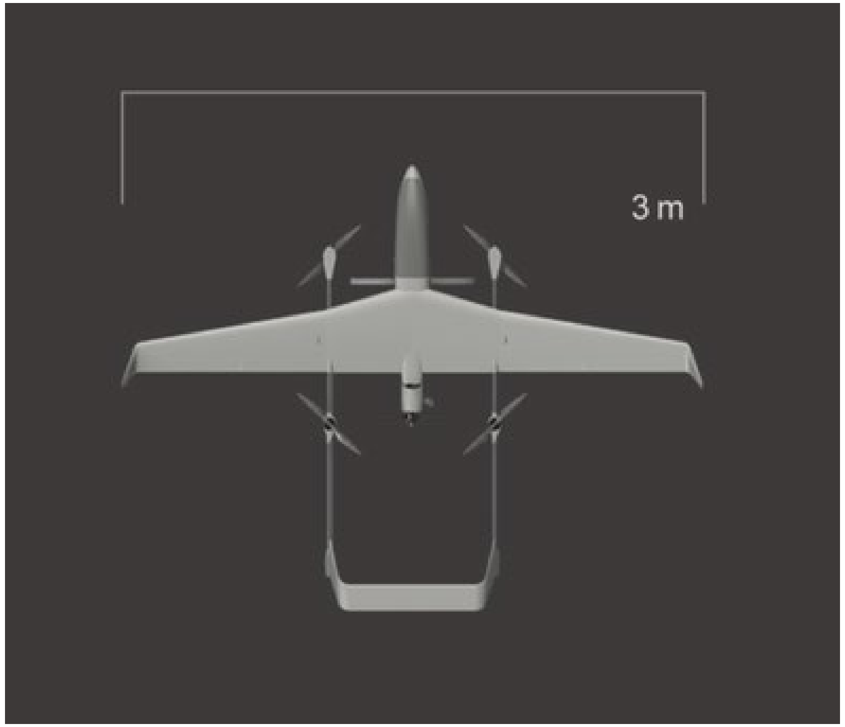
Maariskin kartta

- Maariskin kartta muodostetaan Suomen alueelle Tilastokeskuksen ruututietokannasta



Alustavan maariskin määrittely

$$E_k = \frac{1}{2}mv^2 = 1800\ \text{J}$$



Weight

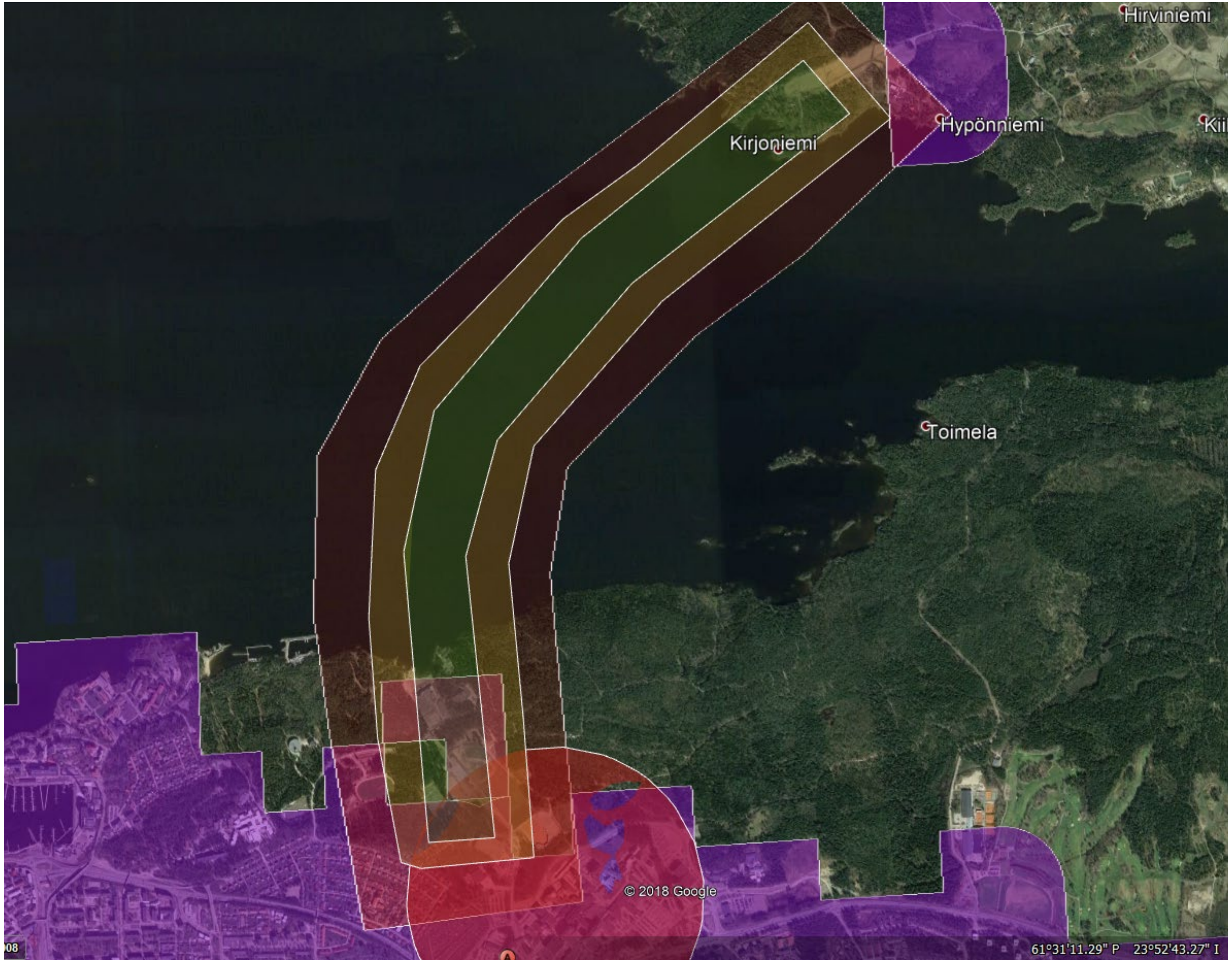
MTOW (Maximum Takeoff Weight)	9 kg
Empty Airframe	3 kg
RTF (Dry Weight)	6 kg
RTF (Including Fuel & Batteries)	8.5 kg
Max Payload	0.5 kg

Flight Performance

Stall Speed	13-16 m/s
Cruise Speed	20 m/s
VNE (Velocity Never Exceed)	30 m/s
Maximum Crosswind	10-15 m/s
Maximum Service Ceiling	10,000 ft. AMSL
Flight Time (VTOL)	Up to 3 minutes
Flight Time (Fixed Wing)	Up to 6+ hours
Temperature Range	-10° C to +50° C

Toiminta-alue

- Mikä alue tulee valita taulukosta



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Alustavan maariskin määrittely

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 2 – Intrinsic Ground Risk Classes (GRC) Determination

Alustava maariskin arvio **GRC = 6**

Main body

Final Ground Risk Determination

Lopullisen maariskin määrittely

- Alustavaa maariskiä voidaan vähentää kolmella eri tavalla
  - Vähennetään vaarassa olevien ihmisten määrää M1
  - Vähennetään seuraamuksia törmäyksestä M2
  - Vaikuttavalla ja kattavalla hätätilannesuunnitelmalla M3

- Riskinvähennyksistä saa sitä enemmän hyötyä mitä paremmin vaikuttavuus voidaan todistaa

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

Table 3 – Mitigations for Final GRC determination

Annex B

Ground Risk Mitigations

M1 – Strategic mitigations for ground risk

- M1 is a strategic mitigation meant to reduce the number of people at risk and always has to involve the following steps for assessment of the integrity levels:
  - Definition of the ground risk buffer and resulting ground footprint
  - Evaluation of people at risk
  - Criteria to assess the level of integrity and assurance of M1 type mitigations are provided in Section a), except for the specific case of tether for which dedicated criteria have been developed in Section b).

- **The criterion has to meet a Low or Medium or High Level of Integrity and Assurance to provide the appropriate level of robustness**

M2 – Effects of ground impact are reduced

- Mitigations M2 are meant to reduce the effect of ground impact once the control of the operation is lost by reducing the effect of the UA impact dynamics (area, energy, impulse, transfer energy …), e.g. a suitable parachute.

- There are 3 criterion for this mitigation:

- Criterion #1 (Technical design)
- Criterion #2 (Procedures, if applicable)
- Criterion #3 (Training, if applicable)

M3 – Emergency Response Plan – in place, operator validated and effective

- An Emergency Response Plan (ERP) should be defined by the applicant to cope with cases of loss of control of the operation (*), i.e. cases of emergency situations where the operation is in an unrecoverable state.
- This can be translated as cases:
  - where the outcome of the situation highly relies on providence; or
  - which could not be handled by a contingency procedure; or
  - when there is grave and imminent danger of fatalities.

- The ERP to be proposed by an applicant is different from the emergency procedures and is expected to cover:
  - the plan to limit crash escalating effect (e.g. notify first responders ...), and
  - the conditions to alert ATM.

Lopullisen maariskin määrittely

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

Table 3 – Mitigations for Final GRC determination

Lopullinen maariskin arvio 6 -1 -1 +0 = 4

GRC 4

Main body

Determination of Initial Air Risk Class

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Alustavan ilmariskin määrittely

Atypical Airspace is defined as;

a) Restricted Airspace or Danger Areas;

b) Airspace where normal manned aircraft cannot go (e.g. airspace within 100 ft. of buildings or structures);

c) Airspace characterization where the encounter rate of manned aircraft (encounter is defined as proximity of 3000 ft. horizontally and ± 350 ft. vertically) can be shown to be less than 1E-6 per flight hour during the operation);

d) Airspace not covered in Airspace Encounter Categories (AEC) 1 through 12

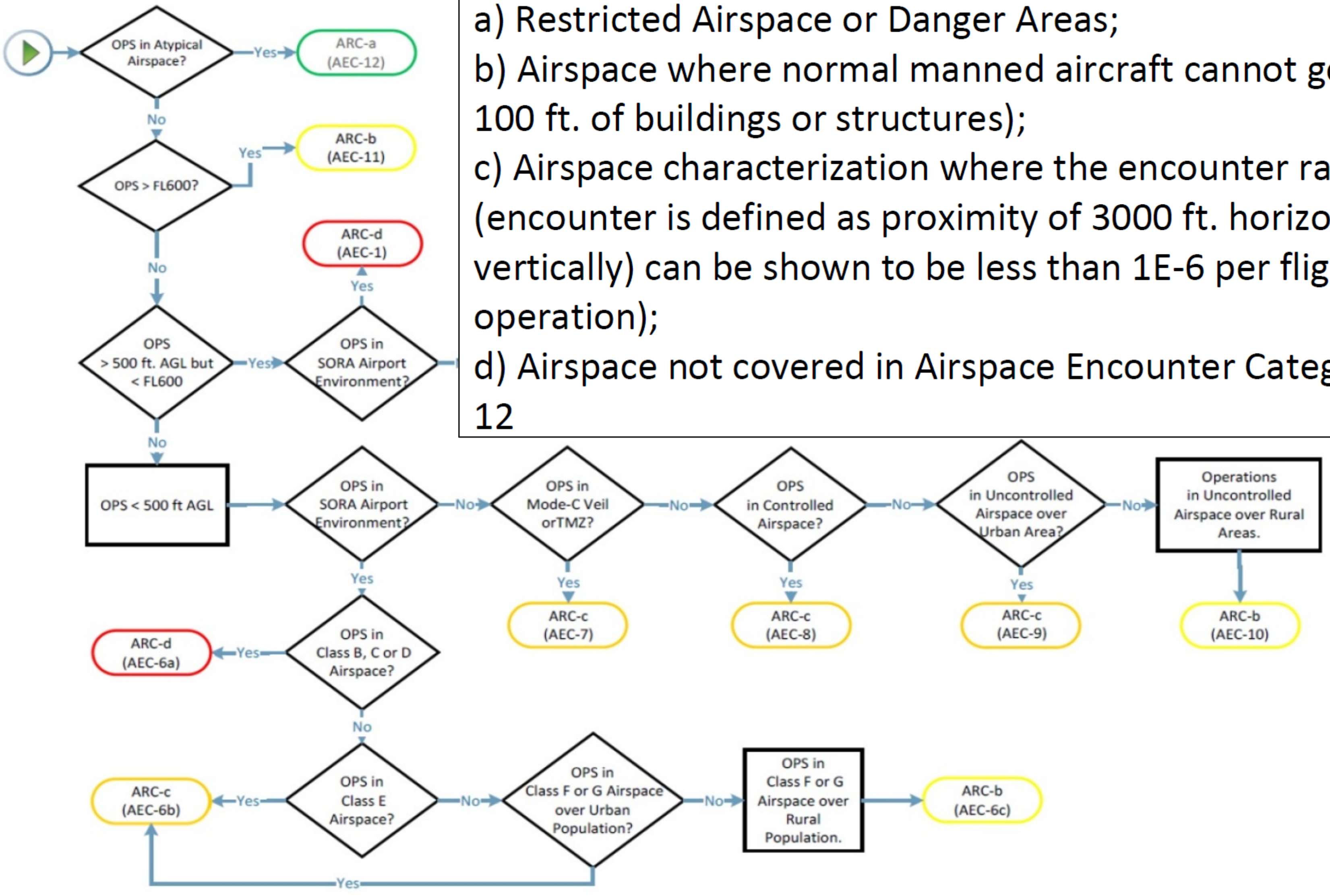
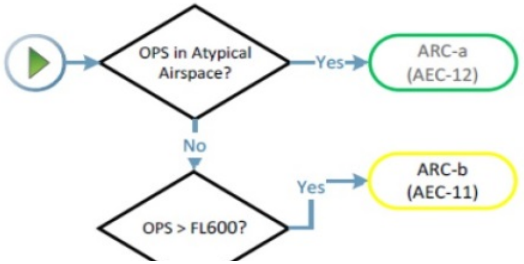


Figure 4 – ARC assignment process

Alustavan ilmariskin määrittely



JARUS-ilmariskin perustaulukko on erittäin konservatiivinen arvio

Suomessa tullaan tekemään erilliset määrittelyt ilmariskin alueista, jolloin JARUS-taulukkoa ei käytetä

2.4.2 Step #4 - Determination

(a) 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 applicant should use that service to determine the initial ARC, and go directly to section 2.4.3 “Application of Strategic Mitigations” to reduce the initial ARC.

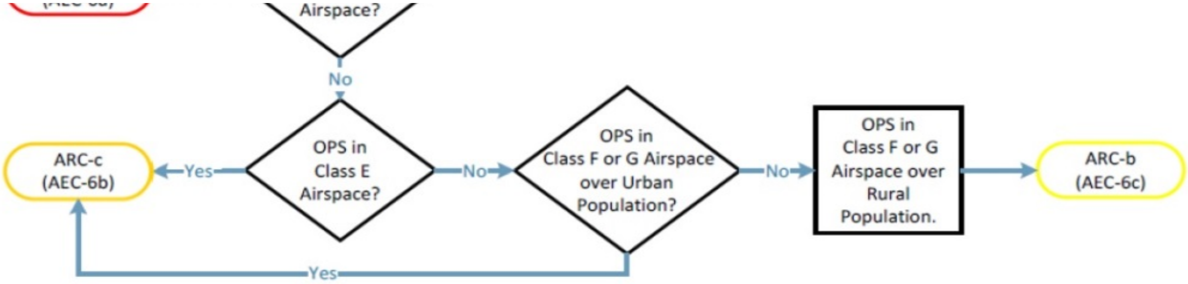


Figure 4 – ARC assignment process

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Ilmariskin kartta

- Ilmariskin kartta on mahdollista muodostaa datasta
- Kartan saa vastaamaan SORA-ilmariskin kategorioita

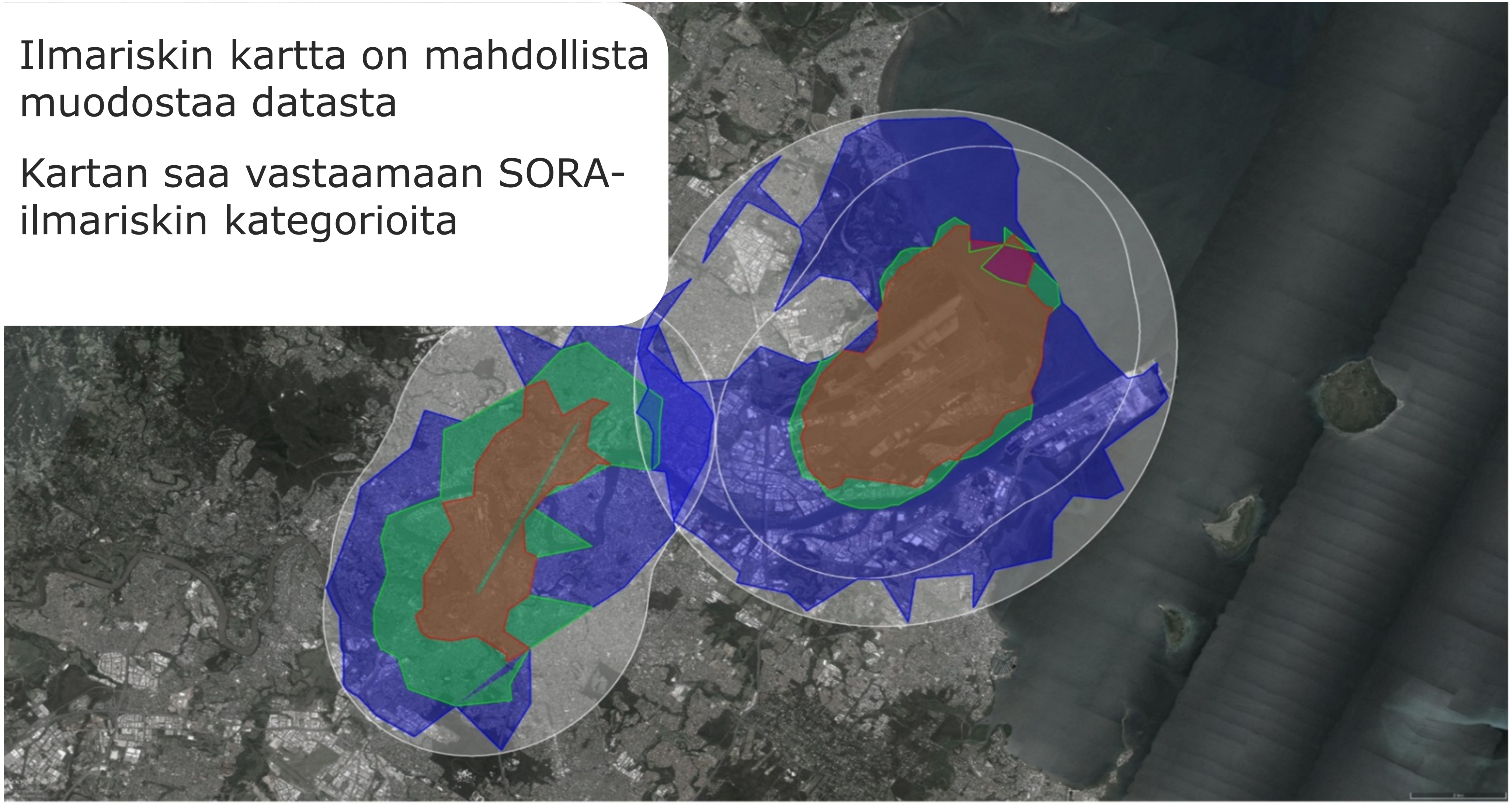
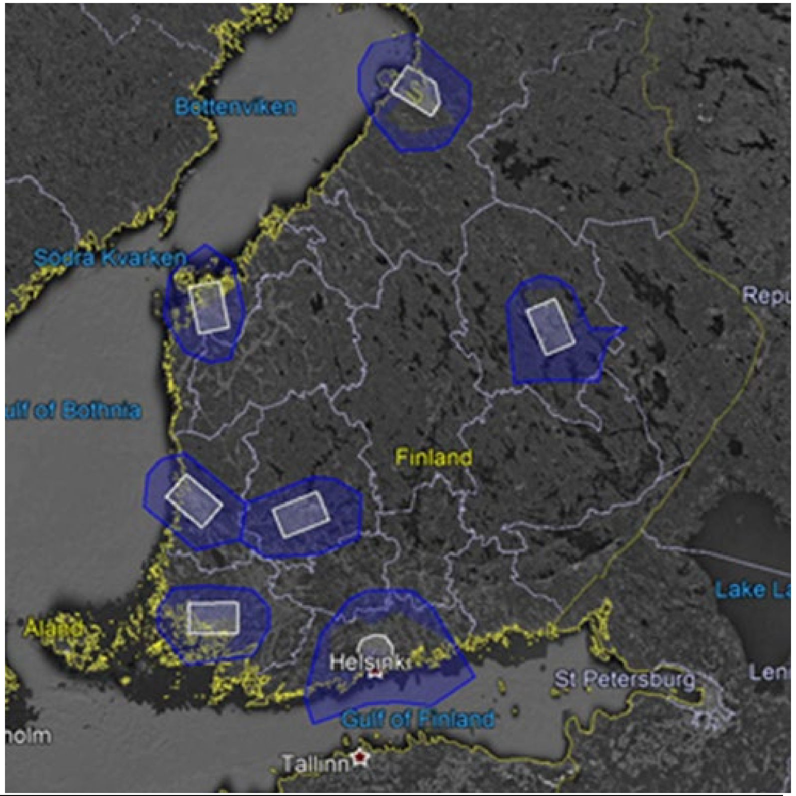


Fig. 6. Candidate data-driven exclusion zones (■,■,■) for both terminal $\bar{C}_{A_k}$ and heliport $\bar{C}_{H_k}$ regions around Brisbane. Increasing k is depicted from blue to red. Currently enforced exclusion zones are also depicted (□).

Ilmariskin kartta

- Tutkadatan perusteella ollaan määrittelemässä seitsemän lentoaseman ympäristön riskit
- Muilla alueilla tullaan tekemään asiantuntija-arviot
- Näin vältetään yliampuvat vaatimukset usealla alueella



ARC classes altitude > 200 m AGL	**Encounter probability** encounters / hour	**Encounter definition 1** altitude > 200 m AGL
ARC-a	$P_a <= 10^{-6}$	1000 m horizontal separation ±100 m vertical separation
ARC-b	$10^{-6} < P_b <= 10^{-4}$	1000 m horizontal separation ±100 m vertical separation
ARC-c	$10^{-4} < P_c <= 10^{-2}$	1000 m horizontal separation ±100 m vertical separation
ARC-d	$P_d > 10^{-2}$	1000 m horizontal separation ±100 m vertical separation

Annex C

Strategic Air Risk Mitigations

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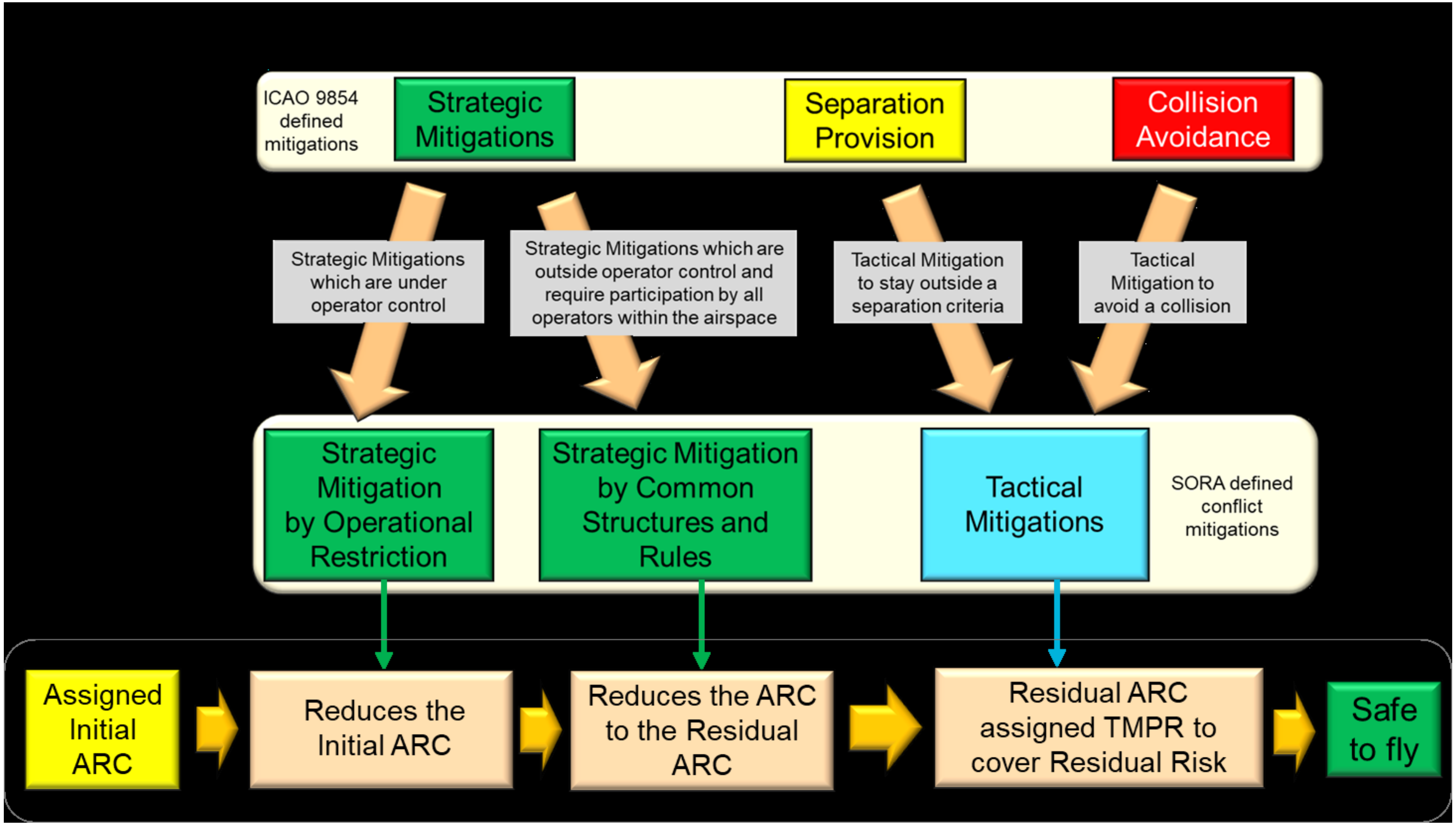
Ilmariskin vähentäminen

- Ilmariskiä voi valinnaisesti vähentää rajoittamalla omaa toimintaansa → Strategic Mitigation



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Annex C Strategic Mitigation Collision Risk Assessment

- What is a strategic mitigation?

- **Strategic Mitigation consists of procedures and operational restrictions intended to reduce the UAS encounter rates or time of exposure, prior to take-off.**

Strategic Mitigations are further divided into:

- Mitigations by Operational Restrictions: Mitigations that are controlled by the UAS operator
- Mitigations by Common Structures and Rules: Mitigations which cannot be controlled by the UAS operator

Strategic mitigations by operational restrictions

- Operational Restrictions are controlled4 by the operator and intended to mitigate collision risk prior to take-off. This section provides details on Operational Restrictions, and examples on how these can be applied to UAS operations.
- Operational Restrictions are the primary means an operator can apply to reduce collision risk using strategic mitigation(s). The most common Mitigations by Operational Restriction are:

1. Mitigation(s) that **bound the geographical volume** in which the UAS operates (e.g. certain boundaries or airspace volumes)
2. Mitigation(s) that **bound the operational time frame** (e.g. restricted to certain times of day, such as fly only at night)
3. **Mitigating exposure time** is possible in some cases, but may be more difficult to apply.

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Strategic mitigations by common structures and rules

- Strategic Mitigation by Common Structures and Rules requires all aircraft within a certain class of airspace to follow the same structures and rules.
- These structures and rules work to lower collision risk within the airspace.
- All aircraft in that airspace must participate and only the competent authorities and/or ANSP have the authority to set requirements for those aircraft.
- The UAS operator does not have control over the existence or level of participation of the airspace structure or the application of the flight rules.
- Therefore, Strategic Mitigation by Common Structures and Rules is applied by the competent authorities and/or ANSP only. It is either available to the UAS operator, or not.

Ilmariskin vähentäminen

- Tilapäisellä vaara-alueella toimiminen ei ole riskin vähennys määritelmällisesti vaan toiminta-alue (Atypical airspace)
- Toiminta-ajan rajaaminen esim. yölle, jolloin läheinen lentoasema saattaa olla kiinni, voi kelvata strategiseksi riskin vähennykseksi, jolla voidaan laskea alustavaa kartasta saatua arviota
- Strategiset ilmariskin vähennykset ovat vapaaehtoisia
- Taktiset ilmariskin vähennykset ovat pakollisia

Annex D

Tactical Air Risk Mitigations

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Annex D Tactical Mitigation Collision Risk Assessment

- What is a tactical mitigation?

- A Tactical Mitigation is a mitigation applied after take-off and for the air risk model it takes the form of a “mitigating feedback loop.” This feedback loop is dynamic in that it reduces the rate of collision by modifying the geometry and dynamics of aircraft in conflict, based on real time aircraft conflict information.

- SORA Tactical Mitigations are applied to cover the gap between the residual risk of an encounter (the residual ARC) and the airspace safety objective. The residual risk is the remaining collision risk after all strategic mitigations are applied.

Two Classifications of Tactical Mitigation

- 1. VLOS, whereby a pilot and/or observer use human vision to detect aircraft and take action to remain well clear and avoid collisions from other aircraft.

- 2. BVLOS, whereby an alternate means of mitigation to human vision, as in machine or machine assistance, is applied to remain well clear and avoid collisions from other aircraft. (e.g. ATC Separation Services, TCAS, DAA, UTM, U-Space, etc.).

Tactical Mitigation Performance Requirement (TMPR) using VLOS

- VLOS is considered an acceptable Tactical Mitigation for collision risk for all ARC levels. Notwithstanding the above, the operator is advised to consider additional means to increase situational awareness with regard to air traffic operating in the vicinity of the operational volume.

- Operational UAS flights under VLOS do not need to meet the TMPR, nor the TMPR robustness requirements. In the case of multiple segments of the flight, those segments done under VLOS do not have to meet the TMPR nor the TMPR robustness requirements.

- In general, all VLOS requirements are applicable to EVLOS. EVLOS may have additional requirements over and above VLOS.

Tactical Mitigation Performance Requirement (TMPR) using BVLOS

- Since VLOS has operational limitations, there was a concerted effort to find an alternate means of compliance to the human "see and avoid" requirements. This alternate means of mitigation is loosely described as "Detect and Avoid (DAA)." DAA can be achieved in several ways, e.g. through ground based detect and avoid systems, air based detect and avoid systems, or some combination of the two. DAA may incorporate the use of varying sensors, architectures, and even involve many different systems, a human in the loop, on the loop, or no human involvement at all.

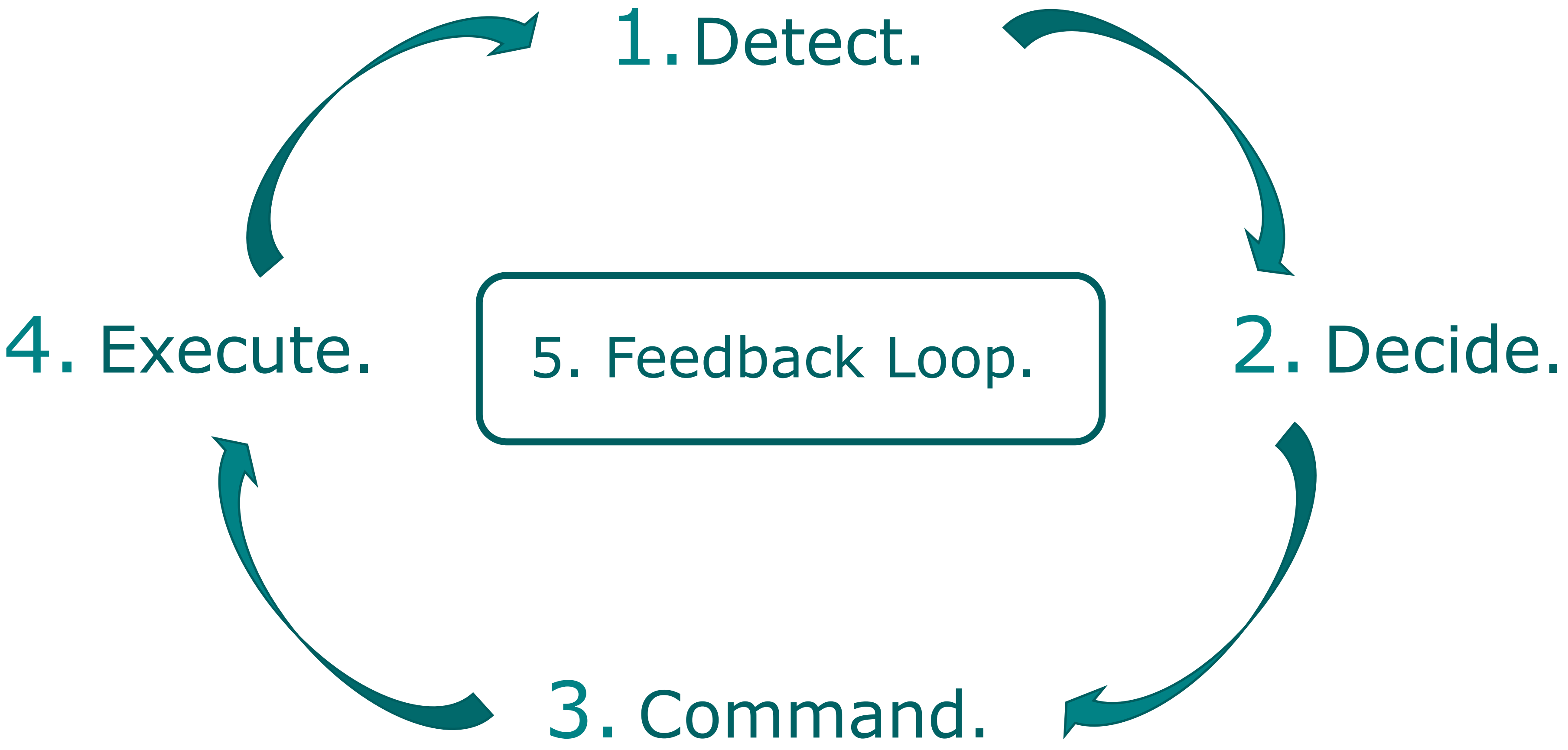
- Tactical Mitigation Performance Requirement (TMPR) provides tactical mitigations to assist the pilot in detecting and avoiding traffic under BVLOS conditions. The TMPR is the amount of Tactical Mitigation required to further mitigate the risks that could not be mitigated through Strategic Mitigation (residual risk). The amount of residual risk is dependent on the ARC. Hence, the higher the ARC, the greater the residual risk, the greater the TMPR.

Tactical Mitigation Performance Requirement (TMPR) Assignment Risk Ratio

Air-Risk Class	Tactical Mitigation Performance Requirement (TMPR)	TMPR System Risk Ratio Objectives
ARC-d	**High Performance**	**System Risk Ratio ≤ 0.1**
ARC-c	Medium Performance	System Risk Ratio ≤ 0.33
ARC-b	Low Performance	System Risk Ratio ≤ 0.66
ARC-a	No Performance Requirement	No System Risk Ratio guidance; although operator/applicant may still need to show some form of mitigation as deemed necessary by the CAA

TMPR qualitative criteria

- Split into 5 sub functions:



Lopullisesta ilmariskin arviosta seuraavat vaatimukset (TMPR – Detect)

Tactical Mitigation Performance Requirements (TMPR)

Function	Tactical Mitigation Performance Requirement (TMPR) Levels			
	TMPR N/A	TMPR Low Performance	TMPR Medium Performance	TMPR High Performance
	ARC a	ARC b	ARC c	ARC d
Detect[2]	No Requirement	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 expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90% of all aircraft in the detection volume[3]. To accomplish this, the applicant will have to rely on one or a combination of the following systems or services: • Air based DAA • Ground based DAA • FLARM[7/4] • Pilot Aware[7/4] • ADS-B In/ UAT In Receiver[7] • ATC Separation Services[8] • UTM Surveillance Service[5] • UTM Early Conflict Detection and Resolution Service[5]	RTCA SC-228 or EUROCAE 105 ACAS / Tutka or similar like requirements

TMPR Qualitative Criterion Table - Decide

- VLOS – No TMPR requirement.
- ARC – a: No requirement.
- ARC – b: The operator must have a documented deconfliction 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.
- ARC – c: All requirements of ARC - b and in addition: The operator provides an assessment of the human/machine interface factors that may affect the remote pilot’s ability to make a timely and appropriate decision.
- ARC – d: A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

TMPR Qualitative Criterion Table - Command

- VLOS – No TMPR requirement.
- ARC – a: No requirement.
- ARC – b: 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.
- ARC – c: 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 3 seconds.
- ARC – d: A system meeting RTCA SC-228 or EUROCAE WG- 105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

TMPR Qualitative Criterion Table - Execute

- VLOS – No TMPR requirement.
- ARC – a: No requirement.
- ARC – b: 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.
- ARC – c: Avoidance may rely on vertical and horizontal avoidance manoeuvring and is defined in standard procedures. Where horizontal manoeuvring is applied, the aircraft shall be demonstrated to have adequate performance, such as airspeed, acceleration rates, climb/descend rates and turn rates.
- ARC – d: A system meeting RTCA SC-228 or EUROCAE WG- 105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

TMPR Qualitative Criterion Table – Feedback Loop

- VLOS – No TMPR requirement.
- ARC – a: No requirement.
- ARC – b: 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.
- ARC – c: The information is provided to the remote pilot with a latency and update rate that support the decision criteria. The applicant provides an assessment of the aggravated closure rates considering traffic that could reasonably be expected to operate in the area, traffic information update rate and latency, C2 Link latency, aircraft manoeuvrability and performance and sets the detection thresholds accordingly.
- ARC – d: A system meeting RTCA SC-228 or EUROCAE WG- 105 MOPS/MASPS (or similar) and installed in accordance with applicable airworthiness requirements.

Main body

SAIL Determination & OSO table

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SAIL-määrittely

SAIL Determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C operation			

Table 5 – SAIL determination

Toimija määrittelee lopulliset kokonaisuuden luotettavuusvaatimukset = SAIL-luokka

- **SAIL I**
- **SAIL II**
- **SAIL III**
- **SAIL IV**
- **SAIL V**
- **SAIL VI**

Taulukosta käy myös ilmi, jos toiminta täytyy toteuttaa Certified-kategoriassa

OSO määrittely

Jokaista SAIL-[...] vaadittavat turvallisuust[...]takokonaisuudesta

- Koulutus
- Lentokelpo[...]
- Alihankkija[...]
- Toimintaol[...]
- ...

Vaatimuksilla on neljä eri tasoa

- O = Optional / ei vaadita
- L = Low
- M = Medium
- H = High

Tarkat kuvaukset vaatimuksista löytyvät Annex E:n sisältä

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

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OSO-määrittely

Kaikki OSO-vaatimukset, jotka vastaavat SAIL-tasoa, tulee täyttää.

OSO Number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
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[h]	O	O	O	L	M	H
OSO#05	UAS is designed considering system safety and reliability	O	O	L	M	H	H
OSO#06	C3 link performance is appropriate for the operation	O	L	L	M	H	H
OSO#07	Inspection of the UAS (product inspection) to ensure consistency to the ConOps	L	L	M	M	H	H
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#09	Remote crew trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#10	Safe recovery from technical issue	L	L	M	M	H	H

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OSO – Operational Safety Objective

- OSO #1 - Ensure the operator is competent and/or proven
- OSO #2 – UAS manufactured by competent and/or proven entity
- OSO #3 - UAS maintained by competent and/or proven entity
- OSO #4 - UAS developed to authority recognized design standards
- OSO #5 - UAS is designed considering system safety and reliability
- OSO #6 - C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation
- OSO #7 - Inspection of the UAS (product inspection) to ensure consistency to the ConOps
- OSO #8, #11, #14 & #21 - Operational procedures
- OSO #9, #15 & #22 - Remote crew training
- OSO #10 & #12 - Safe design
- OSO #13 - External services supporting UAS operations are adequate to the operation
- OSO #16 - Multi crew coordination
- OSO #17 - Remote crew is fit to operate
- OSO #18 - Automatic protection of the flight envelope from human errors
- OSO #19 - Safe recovery from Human Error
- OSO #20 - A Human Factors evaluation has been performed and the Human-Machine Interface (HMI) found appropriate for the mission
- OSO #23 - Environmental conditions for safe operations defined, measurable and adhered to
- OSO #24 - UAS designed and qualified for adverse environmental conditions

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Annex E

Operational Safety Objectives

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Principle description

- Annex E provides assessment criteria for the integrity (i.e. safety gain) and assurance (i.e. method of proof) of Operation Safety Objectives (OSOs) proposed by an applicant.
- Annex E does not cover the Level of Involvement (LoI) of the Competent Authority. Lol is based on the Competent Authority assessment of the applicant’s ability to perform the given operation.
- To achieve a given level of integrity/assurance, when more than one criterion exists for that level of integrity/assurance, all applicable criteria need to be met.

Principle description (Cont.)

- When criteria to assess the level of integrity or assurance of an Operation Safety Objective rely on “standards” not yet available, the OSO needs to be developed in a manner acceptable to the competent authority.
- Annex E intentionally uses non-prescriptive terms (e.g. suitable, reasonably practicable) to provide flexibility to both the applicant and the Competent Authorities. This does not constrain the applicant in proposing mitigations, nor the Competent Authority in evaluating what is needed on a case by case basis.
- This annex in its entirety also applies to single-person organizations.

OSO Levels of Robustness

- **Low:** low level of integrity and assurance

A Low level of assurance can be one for which the applicant declares that the required level of integrity has been achieved.

- **Medium:** medium level of integrity and assurance

A Medium level of assurance can be one for which the applicant provides supporting evidence that the required level of integrity has been achieved. This is typically achieved by means of testing (e.g. for technical mitigations) or by proof of experience (e.g. for human-related mitigations).

- **High:** high level of integrity and assurance

A High level of assurance is typically one for which proof of the achieved integrity has been accepted by a competent third party.

OSO Levels of Robustness

	Low Assurance	Medium Assurance	High Assurance
Low Integrity	Low robustness	Low robustness	Low robustness
Medium Integrity	Low robustness	Medium robustness	Medium robustness
High Integrity	Low robustness	Medium robustness	High robustness

Vaaditut standardit

- SORA viittaa Annex E:n sisällä useasti viranomaisen hyväksymiin standardeihin vaatimuksissa. Näitä standardeja ei olla vielä asetettu.
- AW Drones -projekti etsii sopivia standardeja tukemaan SORA-menetelmää.

5. OSOs related to Safe design

OSO #10 - Safe recovery from technical issue

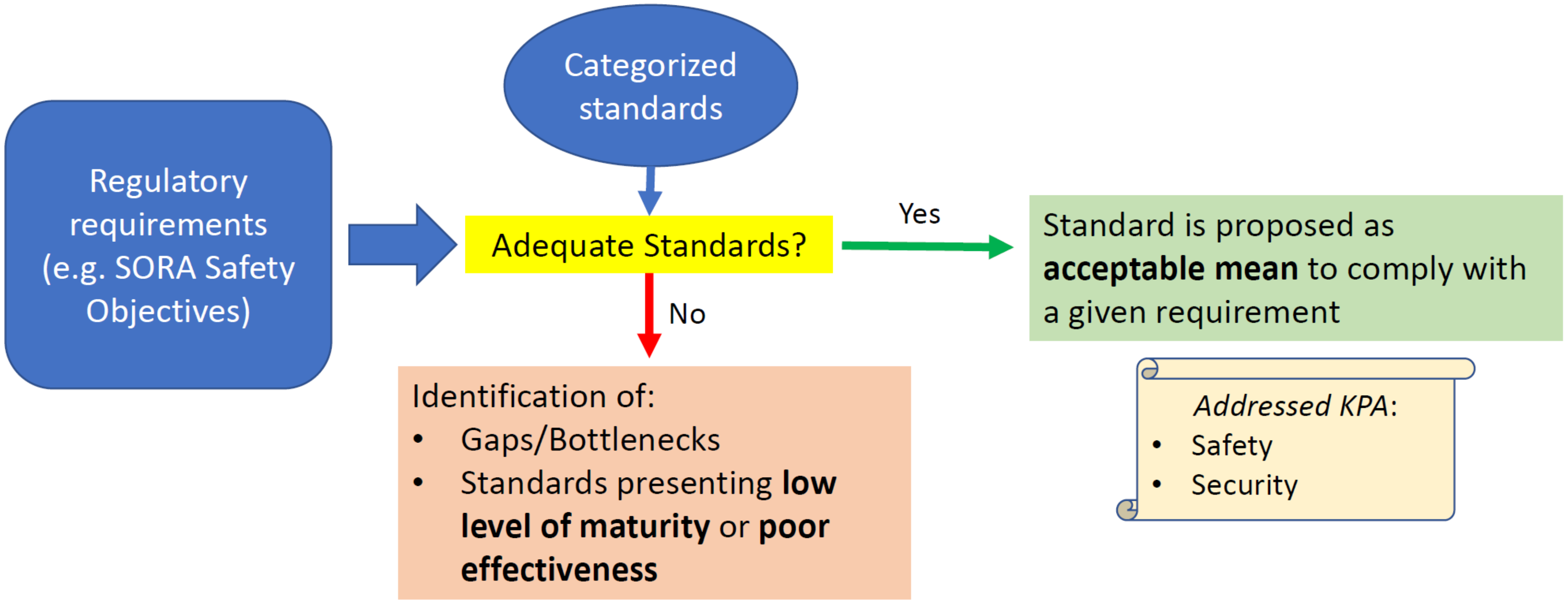
OSO #12 - The UAS is designed to manage the deterioration of external systems supporting UAS operation

		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #10 & OSO #12	Criteria	When operating over populous areas or gatherings of people, it can be reasonably expected that a fatality will not occur from any probable[1] failure[2] of the UAS or any external system supporting the operation.	When operating over populous areas or gatherings of people: • It can be reasonably expected that a fatality will not occur from any single failure[3] of the UAS or any external system supporting the operation. Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could directly lead to a failure affecting the operation in such a way that it can be reasonably expected that a fatality will occur are developed to a standard considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority[4].	Same as Medium
	Comments	*[1] For the purpose of this assessment, the term "probable" should be interpreted in a qualitative way as, "Anticipated to occur one or more times during the entire system/operational life of an UAS".* *[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.*	*[3] Some structural or mechanical failures may be excluded from the no-single failure criterion if it can be shown that these mechanical parts were designed to a standard considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority* *[4] National Aviation Authorities (NAAs) 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.*	

AW Drones – project defining standards

AW DRONES

Methodology - Developing a “meta” standard



This project has received funding from European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No°824292.

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AW Drones – project defining standards

AW DRONES

Scope

- Year 1: Standards required to support effectively the Specific Operations Risk Assessment (**SORA**) methodology
- Year 2: Standards supporting the development of **U-Space** in Europe
- Year 3: Standards needed to support the operation of **highly automated UAS** and to ensure that they can be operated safely in a variety of applications

Iterative approach throughout the project duration

This project has received funding from European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No°824292.

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Ehdotettuja standardeja muutamien vaatimusten täyttämiseksi

Vaatimus		Ehdotettuja standardeja
OSO 5 **OSO 10 & 12**	Functional Hazard Assessment FHA Installation Appraisal	• JARUS AMC RPAS.1309 • ASTM F3309/F3309M -18 • FAA AC-23.1309-1E
M2	Laskuvarjo	• ASTM F3322-18
UAS.SPEC.050	Melunmittaus ja arvon merkitseminen laitteeseen (sama kuin Open)	• EN ISO 3744:2010
-	Valaistus standardi (sama kuin Open)	• CEN – (kehitteillä)
-	Geo-awareness (sama kuin Open)	• CEN – (kehitteillä)
-	Remote ID (Network vs Direct broadcast)	• OpenDroneID • U-space-standardi (kehitteillä)

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Step 9

Adjacent Area considerations

Step 9 – Adjacent Area/Airspace Considerations

- Safety requirements for containment are:
  - 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:
    i. design and installation features (independence, separation and redundancy);
    ii. any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the ConOps.

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Step 9 – Adjacent Area/Airspace Considerations

The following three safety requirements in the next slide apply to 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

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Step 9 – Adjacent Area/Airspace Considerations

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.

Kertaus SORA-prosessin vaiheista

- Toimintakuvaus (CONOPS)
- Maariskin luokka (GRC)
- Maariskin vähennykset (Ground Risk Mitigations)
- Ilmariskin luokka (ARC)
- Strategiset ilmariskin vähennykset (Strategic mitigations)
- Taktiset ilmariskin vähennykset (TMPR)
- Luotettavuusvaatimukset (OSO)
- Ympäröivien alueiden huomioiminen (Adjacent area consideration)

- **Viimeiseksi kaiken dokumentaation kerääminen hakemusta varten**

Kiitos

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Ylitarkastaja

Liikenne- ja viestintävirasto Traficom