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Federal Department of the Environment, Transport, Energy and Communications DETEC
Federal Office of Civil Aviation FOCA
Unmanned Aircraft Systems (UAS)

FOCA GM

Guidance **M**aterial

How to apply for an Operational Authorisation based on a Specific Operational Risk Assessment (SORA 2.0)

Guidance to FOCA-UAS-APP-SORA2.0-P1 and FOCA-UAS-APP-SORA2.0-P2: Application Forms for an Operational Authorization (Parts 1 and 2)

Scope	AMC and GM to Article 11 of Implementing Regulation (EU) 2019/947 (JARUS SORA v2.0)
Applies to	UAS Operations in the “Specific” category, for which an operational authorisation is required
Valid from	01.12.2025
Version	ISS 02 / REV **01**

Document Reference	FOCA-UAS-GM-SORA
Document Owner	FOCA / Unmanned Aircraft Systems (UAS)
Distribution	External

Log of Revision (LoR)

Date	Issue	Revision	Highlight of Revision	Prepared by	Released by
07.10.2022	1	0	First Issue – UAS	UAS/Ops.	UAS/Lead
29.06.2023	1	1	• §0.12, Transport of DG • §4, Definition of “urban” • §9, Integration of FOCA AltMoc Containment • App. 1, Note on Ground Visibility • App. 2, Contingency Volume – Vertical • App. 2, Contingency Maneuver S_CM • App. 2, Note on Maximum Operating Speed	UAS/Ops.	UAS/Lead
01.11.2023	1	2	• §0.13.1 EVLOS – further definitions • §2.0 Update - from census based population density map to the new SORA ground risk map • §1.3.1 Added - Reference to Operational Volume calculator Dipul • §9.2 Adjacent area definition - tool AESA	UAS/Ops	UAS/Lead
22.07.2025	2	0	• Various modifications	UAS/Ops	UAS/Lead
28.11.2025	2	1	• Air Risk	UAS/Ops	UAS/Lead

Latest **revisions** are highlighted with a left-sided **blue** vertical bar

Table of Contents (ToC)

List of Abbreviations (LoA)

Acronym	Definition
ADJ	Adjacent Airspace/Area
AGL	Above Ground Level
AIP	Aeronautical Information Publications
AltMOC	Alternative Means of Compliance
AMC	Acceptable Means of Compliance
ATC	Air Traffic Control
AO	Airspace Observer
BAZL	Bundesamt für Zivilluftfahrt
BVLOS	Beyond Visual Line of Sight
CAA	Civil Aviation Authority
CD	Characteristic Dimension
CG	Centre of Gravity
CV	Contingency Volume
DABS	Daily Airspace Bulletin Switzerland
DETEC	Department of the Environment, Transport, Energy and Communications (DETEC)
DVR	Design Verification Process
EASA	European Union Aviation Safety Agency
EC	European Commission
ED	European Decision
EU	European Union
EVLOS	Extended Visual Line of Sight
FG	Flight Geography
FOCA	Federal Office of Civil Aviation
GM	Guidance Material
GRB	Ground Risk Buffer
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
MTOM	Maximum Take-Off Mass
NOTAM	Notice to Airman
OAT	Operational Authorisation
OSCA	Ordinance (of DETEC) Special Category Aircraft
OM	Operations Manual
TC	Type Certificate
UA	Unmanned/Uncrewed Aircraft
UAS	Unmanned/Uncrewed Aircraft System
SORA	Specific Operations Risk Assessment
VLOS	Visual Line of Sight

Further accronyms are listed under: easa.europa.eu/abbreviations

Introduction

The current Guidance Material (GM) is intended to assist an organisation/operator in the administrative matters of applying and obtaining an operational authorisation and facilitate liason with the Federal Office of Civil Aviation (FOCA). It does not represent a comprehensive and complete set of requirements and it should not be used as a substitute for the individual assessment of the applicable regulatory requirements. An understanding of the risk assessment methodology can be found in JARUS SORA (jarus-rpas.org) and EASA Easy Access Rules (easa.europa.eu) and their understanding are needed for a successful application and authorisation.

Purpose

The purpose of this document is to guide applicants in providing the necessary information related to applications for an operational authorization and conduct a Specific Operational Risk Assessment (SORA Version **2.0**) required for the operation.

Intended use

This Guidance Material is intended to support applicants in completing the operational authorization request for UAS operations in the 'Specific' category. It should be used in conjunction with Application Form Part 1 (Ref. FOCA-UAS-SORA-APP-1). While the structure of this document may not precisely mirror that of the application form, the corresponding sections are clearly referenced throughout, as indicated below:

	FOCA-UAS-APP-SORA2.0-P1 – Sections X.X to X.X

Disclaimer

The document should be understood as general guidance and one should always keep in mind that the SORA methodology is not a one size fits all approach.

On 01.01.2023, the Implementing Regulation (EU) 2019/947 has entered into force in Switzerland. Article 11 (EU) 2019/947 as well as the related AMC and GM are based on JARUS SORA v2.0, and as of 01.11.2023, the baseline to conduct Operational Risk assessment is:

- Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and 2019/945) Revision from September 2022 - Available in pdf, xml, and online format [online link] Available (01.11.2023)];
- Acceptable Means of Compliance and Guidance Material to Regulation (EU) 2019/947, Issue 1, Amendment 3, [online link] Available (01.11.2023).

GM issued directly from regulation (EU) 2019/947 are highlighted with the following “box” format:

EU2019/947 AMC or Defintion link	

More specific or detailed GM from FOCA are highlighted with the following “box” format:

FOCA GM	

Note: To highlight an information or editorial note, a specific note box is used.

The methodology, related processes, and values proposed in this document are intended to guide the applicant when establishing an operation and performing a corresponding risk assessment. The GM is subject to change in the future and should not be understood as the only way to comply with regulatory requirements. An applicant can provide alternative means to this GM to show compliance with the requirements as long as there is enough evidence that an equivalent level of safety is being achieved.

Terms and Conditions

The use of the male gender should be understood to include male and female persons. When used throughout this GM the terms such as «shall, must, will, may, should, could, etc.» shall have the meaning as defined in the English Style Guide of the European Commission.

Legal References

[1] (OSCA) Ordinance of the Department of the Environment, Transport, Energy and Communications (DETEC) on Special Category Aircraft (SR 748.941) [online link] Available (22.07.2025)

[2] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft and related Annexes, Acceptable Means of Compliance and Guidance Material [online link] Available (22.07.2025)

Other references and sources of information

[3] Luftfahrt-Bundesamt (LBA), Informationen zum Prozess der Betriebsgenehmigung [online link] Available (22.07.2025)

[4] Agencia Estatal de Seguridad Aerea (AESA), Operaciones con UAS/Drones - Categoría Específica [online link] Available (22.07.2025)

[5] Direction Générale de l'Aviation Civile (DGAC), Guide DSAC Mise en œuvre de la méthode SORA, Version 1, Edition 2 du 09.09.2025 [online link] Available (22.07.2025)

[6] Joint Authorities for Rulemaking of Unmanned Systems (JARUS) Working Group 6, JARUS guidelines on Specific Operations Risk Assessment (SORA), Edition Number 2.0, 2019 [online link] Available (22.07.2025)

1 Application Process Overview

The illustration below provides an overview of the application process.

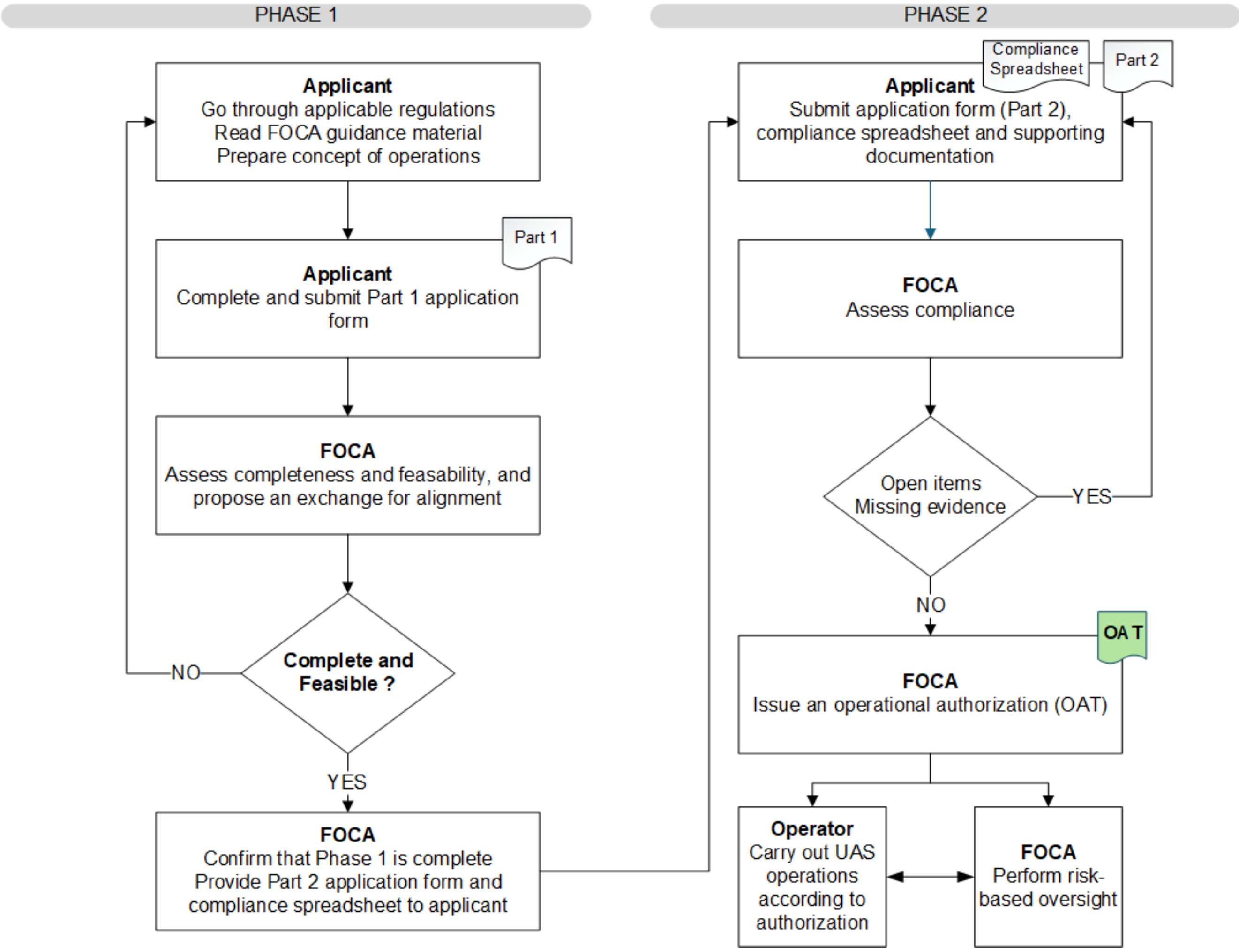


Figure 1 - Application process overview

Part 1 of the application form (FOCA-UAS-APP-SORA2.0-**P1**) is used by applicants to describe their risk assessment in accordance with all steps of SORA 2.0, except Step 8 (Operational Safety Objectives).

Part 2 of the application form (FOCA-UAS-APP-SORA2.0-**P2**) is used to confirm the applicant's risk assessment based on the agreed SAIL level with FOCA (see figure above) and to outline any deviations from the information provided in Part 1.

In addition to Part 2, applicants **must** complete a **compliance spreadsheet**, which details how they demonstrate compliance with all applicable requirements, including those related to Step 8 (Operational Safety Objectives).

The Part 2 form and the compliance spreadsheet are **provided by FOCA** to each applicant individually.

2 General Information

FOCA-UAS-APP-SORA2.0-P1 – Sections **A.1** to **A.7**

2.1 UAS Operator Name

The UAS Operator Name must be the one associated to the UAS operator registration number (see §2.2 below).

2.2 UAS Operator Registration Number

In Switzerland, UAS operator registration is carried out via the dLIS platform. The registration number assigned to each UAS operator follows the format 'CHE' followed by 13 alphanumeric characters.

Note: Third-country operators (i.e., those based outside EASA Member States) must register on the dLIS platform and obtain a 'CHE' UAS operator registration number before submitting an application for operational authorization.

Important: When the UAS operator is an organization (e.g., a company), it is essential that the applicant provides the correct UAS operator number assigned to that organization. Organizational dLIS accounts are managed through the personal dLIS accounts of individuals (e.g., the accountable manager). Since an administrator may also be a registered UAS operator in their own name, and therefore already have a separate UAS operator number, it is crucial that the applicant uses the correct number, specifically, the one corresponding to the organization for which the application is being submitted.

2.3 UID Number

All active companies in Switzerland are given a standardised business identification number (UID). As a unique and unchangeable identifier, it simplifies communication between enterprises and authorities. The UID is made up of the country code 'CHE' and nine digits (e.g., CHE123456789 or CHE-123.456.789).The UID number of a company can easily be found in the UID-Register. More information on the UID number can be found on the Federal Statistic Office website.

Note: Operators who are natural persons, as well as third-country operators, are not required to provide a UID number. In some cases, companies may also lack a UID number (e.g., sole proprietorships.

2.4 Insurance

Anyone operating a drone weighing more than 250 grams is required to hold civil liability insurance with a minimum coverage of CHF 1 million. The insurance information entered in the operator's dLIS account must be accurate and kept up to date.

2.5 Operational Point of Contact

The applicant must designate an operational point of contact, who may not obviously be the UAS operator (in the case of natural persons) nor the accountable manager (in the case of legal entities). This individual will serve as the primary contact for FOCA regarding the application.

2.6 Billing Address

The billing address provided will be used by FOCA to issue invoices related to the application for an operational authorization. If it differs from the address listed in the operator's dLIS account, it must be clearly indicated. It is essential that the billing address is accurate and complies with Swiss postal service requirements.

Note: Third-country operators must exercise particular care when providing their billing address to FOCA and ensure that the information is legible and compliant with Swiss postal service requirements for international addresses.

Applicants are encouraged to use digital forms of invoicing. Further information can be found on the Invoicing and payment options webpage of the FOCA.

2.7 Consulting Company

When the application is supported by a consulting company, applicants are encouraged to indicate this information. However, this is for informal purposes only. **In all cases, the UAS operator remains FOCA's primary point of contact in the context of its role as a competent authority.**

3 UAS and Technical Information

	FOCA-UAS-APP-SORA2.0-P1 – Sections **B.1** to **B.15**

3.1 UAS Manufacturer and UAS Model Name

(EU) 2019/945 (23)	*Any economic operator that either places a UAS intended to be operated in the 'open' category on the market under his own name or trademark, or modifies a UAS intended to be operated in the 'open' category in such a way that compliance with the applicable requirements may be affected, should be considered to be the manufacturer and should assume the obligations of the manufacturer.*

(EU) 2019/945 Art. 3 (13)	*'manufacturer' means any natural or legal person who manufactures a product or has a product designed or manufactured, and markets that product under their name or trademark;*

When operating an UAS with a class identification label, please refer to EASA Drones for EU Operations webpage to ensure the UAS manufacturer and model are correctly identified.

Note: In certain edge cases, accurately identifying the UAS manufacturer and model may be challenging. Please refer to The 'Blue Guide' on the implementation of EU product rules 2022 for further guidance.

3.2 Maximum Characteristic Dimension

The maximum UAS characteristic dimension or "CD" is the **maximum possible length of a straight line that can be spanned from one point on the UA geometry to another point**. Propellers and rotors are part of the geometry, whereby their most unfavourable position is considered. In other words, it is the width of the UA in the direction transvrsal to the direction of flight.

For fixed-wing UA, regardless of the number of planes, including hybrid configurations, the UA characteristic dimension is the **wingspan**.

For rotorcraft UA (e.g. helicopters or gyroplanes), the UA characteristic dimension is the **diameter of the main rotor**.

For VTOL-capable aircraft (VCA), such as multicopters, the UA characteristic dimension is defined by the **maximum distance** (i.e. the diagonal distance) **between the blade tips**.

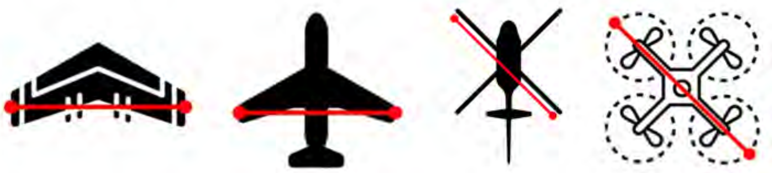


Figure 2 - Maximum characteristic dimension illustration

3.3 Maximum Take-Off Mass (MTOM)

(EU) 2019/947 GM1 Art.2(22) Definitions	*MTOM is the maximum mass defined by the manufacturer or the builder, in the case of privately built UAS, which ensures the controllability and mechanical resistance of the UA when flying within the operational limits.* *The MTOM should include all the elements on board the UA:* • *all the structural elements of the UA;* • *the motors;* • *the propellers, if installed;* • *all the electronic equipment and antennas;* • *the batteries and the maximum capacity of fuel, oil and all fluids; and* • *the heaviest payload allowed by the manufacturer, including sensors and their ancillary equipment.*

3.4 UAS Maximum Speeds

3.4.1 Maximum commanded airspeed as defined by the manufacturer
The maximum airspeed that the remote pilot or autopilot is allowed to command the UAS to fly, based on the manufacturer's design limits. This value considers airframe, propulsion system, and control system limitations. There is often only one maximum commanded airspeed.

3.4.2 Maximum operational speed(s)
The maximum speed(s) flown within the scope of the intended operation(s) (e.g., specific mode speed). It is the highest speed at which the UAS is expected to operate during a mission under normal conditions. This includes both manual and automatic flight but excludes emergency situations (e.g., fly-away, fail-safe return to home).

3.4.3 Maximum ascend speed
The maximum vertical speed (positive rate) at which the UAS can climb under its own power, as specified by the manufacturer.

3.4.4 Maximum descend speed
The maximum rate of descent the drone can achieve in controlled flight, as defined by the manufacturer.

3.4.5 Maximum descend speed with parachute
The terminal velocity of the drone when it is descending under a deployed parachute system.

3.5 Design Verification Report (DVR) or Type Certificate (TC)
For operation in higher SAIL levels in the 'Specific' category, a DVR or TC might be required. If the UAS has such a certificate, please indicate it.

3.6 Transport of dangerous goods
The definition of dangerous goods is outlined in Art. 2(11) and is listed here for convenience:

(EU) 2019/947 Definition Art. 2(11)	*Dangerous goods' means articles or substances, which are capable of posing a hazard to health, safety, property or the environment in the case of an incident or accident, that the unmanned aircraft is carrying as its payload, including in particular:* • *explosives (mass explosion hazard, blast projection hazard, minor blast hazard, major fire hazard, blasting agents, extremely insensitive explosives);* • *gases (flammable gas, non-flammable gas, poisonous gas, oxygen, inhalation hazard);* • *flammable liquids (flammable liquids; combustible, fuel oil, gasoline);* • *flammable solids (flammable solids, spontaneously combustible solids, dangerous when wet);* • *oxidising agents and organic peroxides;* • *toxic and infectious substances (poison, biohazard);* • *radioactive substances;* • *corrosive substances.*

(EU) 2019/947 AMC	*Under the definition of dangerous goods, blood may be considered to be capable of posing a hazard to health when it is contaminated or unchecked (potentially contaminated). In consideration of Article 5(1)(b)(iii):*

AMC1 Article 2(11)	*(a) medical samples such as uncontaminated blood can be transported in the 'open', 'specific' or 'certified' categories;* *(b) unchecked or contaminated blood must be transported in the 'specific' or the 'certified' categories. If the transport may result in a high risk for third parties, the UAS operation belongs to the 'certified' category (see Article 6 1.(b) (iii) of the UAS Regulation). If the blood is enclosed in a container such that in case of an accident, the blood will not be spilled, the UAS operation may belong to the 'specific' category, if there are no other causes of high risk for third parties.*

(EU) 2019/947 GM1 Article 2(11)	*The definition of 'dangerous goods' in Article 2(11) of the UAS Regulation stems from the definition and classification of 'dangerous goods' in the ICAO Technical Instructions. ICAO Advisory Circular (AC) 102-37, Revision 0, issued on 23 June 2020, contains further information. Under the definition of 'dangerous goods' in Article 2(11), blood is considered capable of posing a hazard to health when it contains or may contain infectious substances.'Infectious substances' means substances that are classified under Division 6.2 of the Technical Instructions. The definition and classification of such substances are also available in the above-mentioned ICAO AC 102-37.* *Blood for transfusion and medical samples that are not subject to the provisions of the Technical Instructions may be transported in the 'open', 'specific', or 'certified' categories. Blood that contains or potentially contains infectious substances should be transported in the 'specific' or 'certified' categories. If such transport results in a high risk for third parties in case of an accident, the UAS operation falls under the 'certified' category (as per Article 6(1)(b)(iii) of the UAS Regulation). If the blood contains or potentially contains infectious substances and is enclosed in such a container such that the blood will not be spilled in case of an accident, the UAS operation may fall under the 'specific' category if there are no other causes of high risk for third parties.* *Articles and substances which would otherwise be classified as dangerous goods (e.g. fuel, batteries and other goods used during the flight to supply energy to the drone's system) but which are required to be on board the aircraft for the propulsion of the UAS or for the operation of its specialised equipment during transport, or which are required in accordance with the pertinent operating requirements should not be considered as transported dangerous goods and their safety shouldverified during the design verification of the UAS.*

(EU) 2019/947 AMC1 Article 5	***TRANSPORT OF DANGEROUS GOODS IN THE 'SPECIFIC' CATEGORY*** *(a) Dangerous goods may be transported in the 'specific' category of UAS operations only if the UAS operator is able to demonstrate that these goods will not cause harm or damage to third parties or to the environment in case of accident. When compatible with the operation, a crash-protected container, which will prevent the leakage/dispersion of dangerous goods in case of accident, would be acceptable. In this case, the UAS operator should demonstrate that the container is capable of maintaining/protecting the dangerous goods without causing damage or harm to third parties or the environment in case of accident. In demonstrating the conformity of the container, the operational characteristics of the flight (flight speed, altitude, weather conditions, etc.) shall be taken into account, as well as the defining aspects of the geographical area of operation* *(b) The assessment of the operational risk of transporting dangerous goods should take into account the following: (1) the risk that such goods pose to persons that are directly involved in their handling, to the environment, and to third parties and their properties; (2) the hazard posed by the quantity and class of the dangerous goods; (3) the characteristics of the container for the dangerous goods; (4) the level of competence of those handling the dangerous goods; and (5) the geographical area in which the flight will be operated.* *(c) The UAS operator that wishes to carry out operations in the 'specific' category to transport dangerous goods should establish a dangerous goods training programmes for the personnel involved, as required by the Technical Instructions. Such training programmes should be commensurate with the responsibilities of the personnel involved in those operations. The training programmes should be subject to review and approval by the competent authority, and should cover at least the following aspects: (1) dangerous goods terminology; (2) classification of dangerous goods; (3) labelling of dangerous goods; (4) identification of dangerous goods that use 'SDSs' and the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) consumer labelling; (5) use of the dangerous goods list provided in the Technical Instructions; (6) storage and handling of dangerous goods, including but not limited to the segregation of incompatible dangerous goods, dangerous goods loading, and dangerous goods securing; (7) instructions and safety precautions to be provided to employees and third parties; and (8) emergency/reporting procedures included in the ERP in case of an accident/incident with dangerous goods*

FOCA GM On transport of medical samples	Current FOCA's policy on the **transport of medical samples** (only) is to follow ICAO AC 102-37 best practices: • the Operator is required to establish DG Standard Operating Procedures (DG-SOP) for the transport of DG as defined in the section Dangerous Good Standard Operating Procedures of ICAO U-AID Guidance Material; • An Emergency Response Plan shall be available as defined in the 2020 Emergency Response Guidebook (US Department of Transportation, Transport Canada, & Secretaria de comunicaciones y transportes, 2020); • The handling of medical samples and especially the container enclosing the blood samples shall be documented in the ConOps (Chapter on Payload) and/or in the LUC Manual (Chapter on handling of DG) of the Operator and shall follow the packaging directive UN 3373 (Institut für Virologie und Immunologie).

3.7 Mode of Operation - Definitions of VLOS, EVLOS, BVLOS

The definition of these operating modes are outlined on FOCA Website [online link], in (EU) 2019/947 Art. 2 and Art. 11 and reiterated in the next subsections for convenience.

3.7.1 VLOS Definition

(EU) 2019/947 Definition Art. 2(7)	*'visual line of sight operation' ('VLOS') means a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions*

In VLOS, the remote pilot in command needs to ensure following tasks:

- monitor the UA position with continuous visual contact;
- monitor the airspace and the environment (situational awareness) with visual contact;
- keep the command and control of the UA (can be automated with the option for the pilot to intervene).

Refer to §9.1.1 for a detailed guidance on determining VLOS maximum range.

3.7.2 EVLOS Definition

(EU) 2019/947 AMC AMC1 to Art. 11, 2.3.1(g)	*A UAS operation whereby the remote pilot maintains uninterrupted situational awareness of the airspace in which the UAS operation is being conducted via visual airspace surveillance through one or more human VOs, possibly aided by technological means. The remote pilot has direct control of the UAS at all times.* *Note that EVLOS operations are considered as BVLOS operations where the remote pilot is supported by one or multiple airspace observers (located in a way that the UA is always at a VLOS distance from the remote pilot or from one airspace observer that is able to scan the sky and communicate in real time with the remote pilot informing them of possible other manned or unmanned aircraft flying in the area of operation* ***Important note:* Under SORA 2.0,** *EVLOS operations are to be considered BVLOS for the intrinsic GRC (iGRC) determination.*

For airspace observers (AO), technical aids can be used, but their effect on workload and other implications need to be looked further into in the assessment.

(EU) 2019/947 AMC AMC1 to Art. 11, 2.4.4	*For Air Risk / TMPR:* *(c) In general, all VLOS requirements are applicable to EVLOS. EVLOS may have additional requirements over and above those of VLOS. The EVLOS verification and communication latency between the remote pilot and the observers should be less than 15 seconds.* *(d) Notwithstanding the above, the applicant should have a documented VLOS de-confliction scheme, in which the applicant explains which methods will be used for detection, and defines the associated criteria applied for the decision to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of phraseology will have to be described as well.*

3.7.3 BVLOS Definition

(EU) 2019/947 Definition Art. 2(8)	*'beyond visual line of sight operation' ('BVLOS') means a type of UAS operation which is not conducted in VLOS;*

Note on FPV Operations:

Refer to Article 4, 1 (d), UAS.OPEN.060 2) b) , GM1 UAS.OPEN.060(4):

ROLE OF THE UA OBSERVER AND FIRST PERSON VIEW

"The remote pilot may be assisted by a UA observer helping them to keep the UA away from obstacles. The UA observer must be situated alongside the remote pilot in order to provide warnings to the remote pilot by supporting them in maintaining the required separation between the UA and any obstacle, including other air traffic.

UA observers may also be used when the remote pilot conducts UAS operations in first-person view (FPV), which is a method used to control the UA with the aid of a visual system connected to the camera of the UA. In any case, including during FPV operations, the remote pilot is still responsible for the safety of the flight.

As the UA observer is situated alongside the remote pilot and they must not use aided vision (e.g. binoculars), their purpose is not to extend the range of the UA beyond the VLOS distance from the remote pilot. Exceptions are emergency situations, for instance, if the pilot must perform an emergency landing far from the pilot's position, and binoculars can assist the pilot in safely performing such a landing."

4 Specific Operations Risk Assessment (SORA)

4.1 Step #1 – Concept of Operations (ConOps)

	FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **1.1** and **1.2**

4.1.1 ConOps: what is it about?

The concept of operations (ConOps) is a **short description of the operation and the concepts behind it**, used to do **a quick review of whether the operation is possible** and what level of requirements would be needed based on a SORA risk assessment.

4.1.2 Requested type of operational authorization

A 'generic' (or 'location-independent') authorization is an operational authorisation that is applicable to an indefinite number of flights taking place in locations generically identified, during the period of validity of the operational authorisation.

A 'precise' (or 'location-dependant') authorization is an operational authorisation that is limited to the number of flights and/or to known locations identified by geographical coordinates.

Please refer to GM2 UAS.SPEC.030(2) of (EU) 2019/947 for additional guidance.

The FOCA must gain sufficient evidence and confidence that the UAS operator is able to complete risk assessment on its own to deliver a 'generic/location-independent' authorization.

Note: Please refer to §13 for further guidance on the volumes.

4.1.3 Operations Manual (OM) Structure

Depending on the complexity of the operations, UAS operators may adopt different strategies to design their Operations Manual. The figure below presents common scenarios and how they may impact the operations manual.

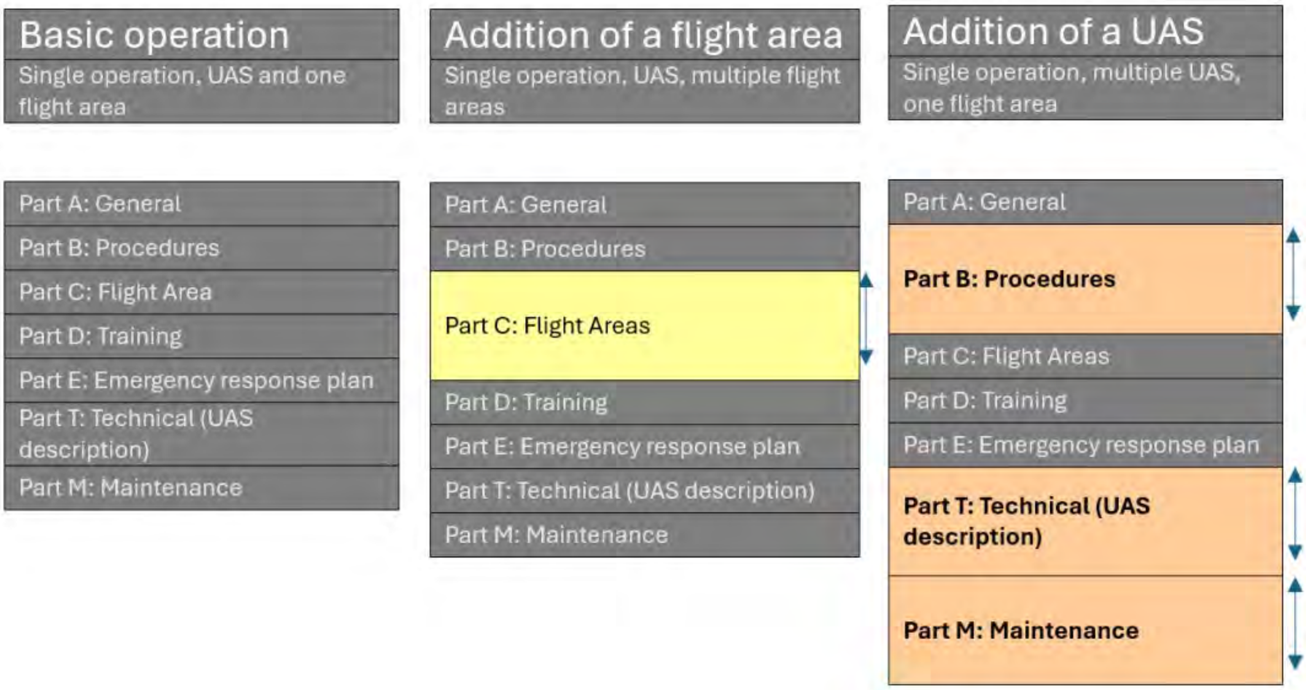


Figure 3 - Common scenarios and how they may impact the operations manual (source: AMC & GM to Regulation (EU) 2019/947 Issue 1, Amendment 3)

Note: Please refer to FOCA-GM-OM to further guidance on the operations manual.

5 Step #2 – Intrinsic Ground Risk Class (iGRC) Determination

FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **2.1** and **2.2**

The intrinsic ground risk relates to the risk of a person being struck by the UAS (in the case of loss of UAS control). To establish the intrinsic GRC, the applicant needs the max UA characteristic dimension and the knowledge of the intended operational scenario.

The applicant needs to have defined the **area at risk** when conducting the operation including:

- the **operational volume** which is composed of the **flight geography** and the **contingency volume**. To determine the operational volume the applicant should 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 should be considered and addressed in this determination;
- whether the area is a controlled ground area or not;
- the associated **ground risk buffer**.

Note: EVLOS operations are to be considered as BVLOS for the GRC determination.

Note: Please refer to §13 for further guidance on the volumes.

5.1 Typical kinetic energy expected (Ekin)

5.1.1 For fixed-wing aircrafts

It should be calculated using the **MTOM** (kg) and **maximum cruise speed** (m/s).

$$E_{kin} = \frac{1}{2} \times m \times v^2$$

5.1.2 For rotorcraft and multicopters

It should be calculated using **MTOM** and **terminal velocity**.

Terminal velocity calculation guidance can be found in the picture below and on [Terminal Velocity Interactive - Glenn Research Center | NASA] [online] Available (01.11.2023).

5.1.3 Example of Ekin calculation

Below is an example calculation of the expected kinetic energy for a multicopter using a method described in [ASSURE A4 Report: UAS Ground Collision Severity Evaluation (2017)], [online link, Available (01.11.2023), pages 111-112]:

- the density of air ρ can be estimated to be (at sea level): 1.225 kg/m^3;
- the Earth gravitational acceleration g : 9.81 m/s^2;
- the MTOM of the UAS;
- the coefficient of drag C_d (conservative estimate for multicopers: 0.96);
- the maximum characteristic dimension (CD) of the UAS ;

Specifications	
Aircraft	
Weight (Battery & Propellers Included)	1380 g

$$r = \frac{D}{2} = 195mm$$

$$A = \pi r^2 * 30\% = 0.036m^2$$

$$C_d = 0.96^*$$

$$V_{terminal} = \sqrt{\frac{2mg}{C_d \rho A}} = \sqrt{\frac{m * 19.62}{A * 1.176}} = 25.5m/s$$

$$E_{kinetic} = \frac{1}{2} mV^2 = 455\,J$$

Figure 4: UAS Typical Ekin example (D is the distance between rotor tips, as described in §0.6)

This example case would fit into the < 1 m and < 700 J class of UAS.

5.2 Operational scenarios

5.2.1 Controlled ground area

(EU) 2019/947 [GM1 Article 2(21)]	Controlled ground area' is an area on the ground (on the surface of the Earth) where the UAS operator is able to ensure that only the persons involved are present. Such area comprises the 'flight geography area', the 'contingency area' and the 'ground risk buffer'. The UAS operator may protect the controlled ground area by means of fencing or using other methods, as appropriate, considering the population density.

<table>
<tr><td>FOCA
GM</td><td>

SORA v2.0 [6]: Controlled ground areas are a way to strategically mitigate the risk on ground (similar to flying in segregated airspace).

A controlled ground area is defined as the intended UAS operational area that **only involves active participants** (if any).

- Active participants are those persons directly involved with the operation of the UAS or fully aware that the UAS operation is being conducted near them.
- Active participants are fully aware of the risks involved with the UAS operation and have accepted these risks.
- Active participants are informed on and able to follow relevant effective emergency procedures and/or contringency plans the assurance that there will be non-active participants in the area of operation is under full responsibility of the operator.

Solutions/options:

- Can be fenced, with physical barriers and/or cordon procedures / security perimeter (e.g., involving police).
- If not fenced:
  - area must be clearly marked with signs;
  - area must be monitored fully by the operator for any people entering area;
  - in addition, a procedure must be established to cope with uninvolved persons entering the controlled ground area take appropriate measures to maintain safety.

Important note: Applicants shall provide the FOCA with sufficient information on how they intend to establish a controlled ground area and effectively ensure compliance with the associated requirements.

</td></tr>
</table>

Please refer to GM1 Article 2(18) Definitions of (EU) 2019/947 for the definition of “uninvolved persons” (by opposition to “persons involved” or “active participants”).

5.2.2 Sparsely populated area

FOCA GM	The acceptable quantitative definition of the population density to be considered as sparsely populated is: **less or equal to 500 ppl/km²**.

5.2.3 Populated area

FOCA GM	The acceptable quantitative definition of the population density to be considered as populated is: **more than 500 ppl/km²**.

5.2.4 Gathering or assembly of people

<table>
<tr><td>(EU) 2019/947
GM1 Article 2(3)</td><td>

Assemblies of people have been defined by an objective criterion related to the possibility for an individual to move around in order to limit the consequences of an out-of-control UA. […].

Qualitative examples of assemblies of people are:

a) sport, cultural, religious or political events;
b) beaches or parks on a sunny day;
c) commercial streets during the opening hours of the shops; and
d) ski resorts/tracks/lanes.

</td></tr>
<tr><td>FOCA
GM</td><td>For the assessment of gatherings/assembly of people within adjacent area, refer to: FOCA UAS AltMoC to SORA Step 9 on Containment [online link] Available (28.11.2025).</td></tr>
</table>

5.3 Tool for the assessment of operational scenario

It is recommended to use [Swisstopo's resources] for the assessment of 'populated' vs. 'sparsely populated' area.

More explicitely, by using the new SORA Ground Risk map (Population Density), also aligned with SORA 2.5, on https://map.geo.admin.ch. Two layers are available to select: "SORA Ground Risk 100" (100m × 100m resolution) and "SORA Ground Risk 200" (200m × 200m resolution)." [Online link; available 28.11.2025].

The map is an estimate of the average distribution of population density derived from Inhabitants (STATPOP) and Employment (STATENT) from the Federal Statistical Office (FSO). Where no swiss data was available, information from the Global Human Settlement Layer (GHSL) of the Euroean Commission was used. The data should be used as a guideline, meaning that discrepancies can be argued accordingly by the applicant in the SORA risk assessment.The use of local or cantonal density maps (such as geo.vd.ch or maps.zh.ch) is also possible, as long as they are provided by an authoritative source.

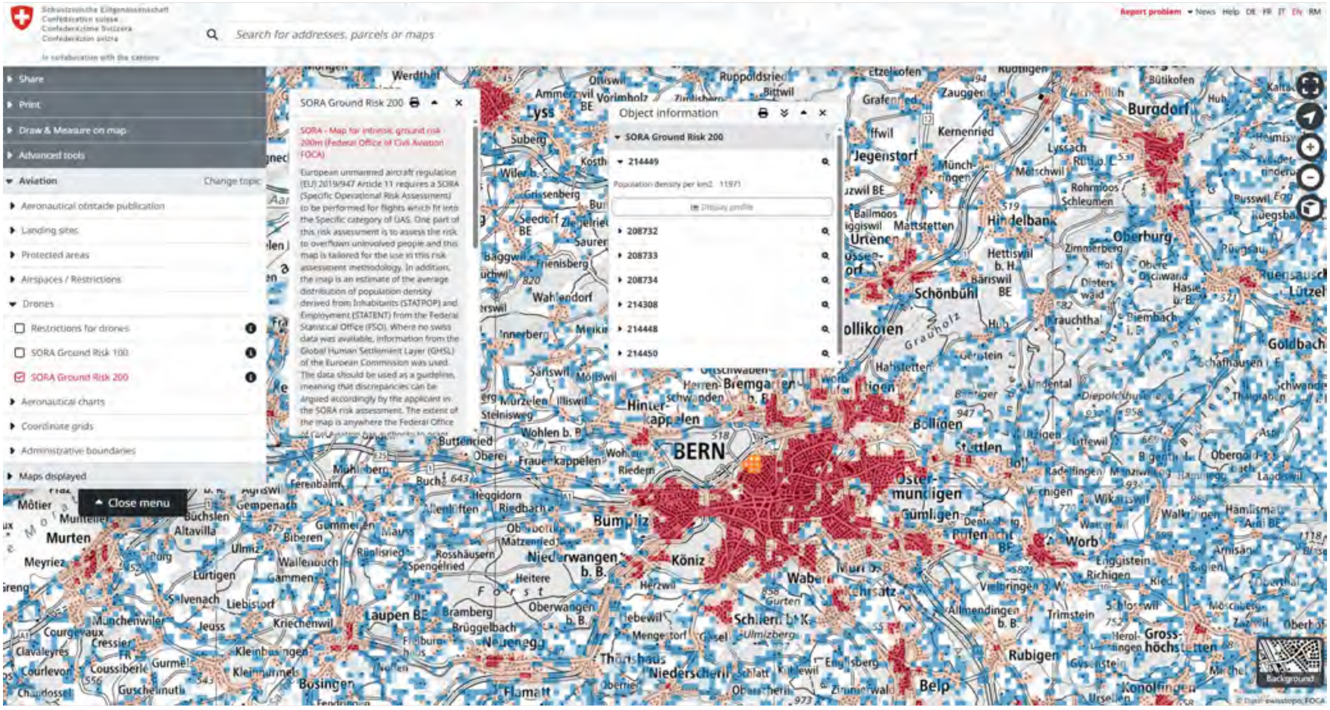


Figure 5 - SORA ground risk 200 layer on map.geo.admin.ch

To determine the type of operational area overflown according to §5.2, the population density provided by the "SORA Ground Risk" layers must be used, with the following transition from quantitative population category to qualitative descriptors:

	Quantative category	**Qualitative descriptor SORA 2.0**
5-50 people per km2 50-500 people per km2 500-5000 people per km2 5000-50000 people per km2	Blue (light **blue**, dark **blue**) [**1-500** people per km²]	Sparsely populated
	Red (light **red**, dark **red**) [**501-50'000** people per km²]	Populated

5.4 Handling Operational volumes overlapping quadrants of different population densities

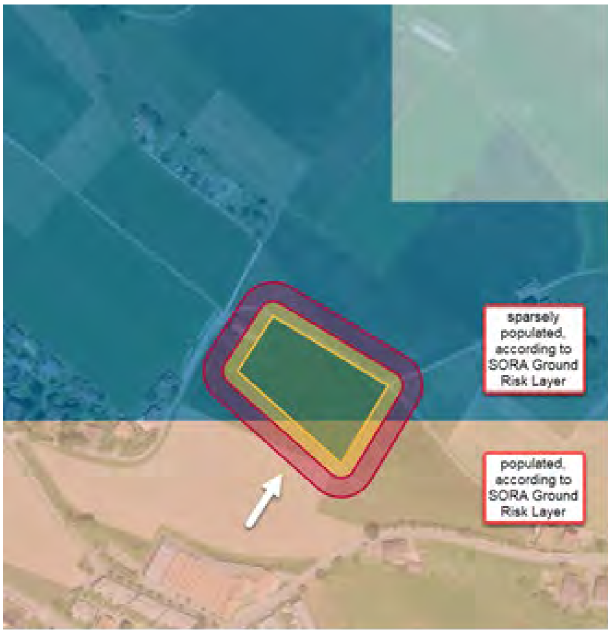
As a general Principle, the population density of the highest populated quadrant within the operational volume is considered.

In special cases, an argumentation and evidence-gathering process can be established to substantiate the population category determination. The following conditions must coincide:

- the operational volume intersects with a highly populated quadrant; and
- the high population density of the quadrant is attributed to a data model artifact.

In such cases, one effective method is conducting an onsite inspection of the specific location.

Example case:



5.5 Mismatch between CD and Ekin

In cases where the kinetic energy and characteristic dimension point to different UAS classes, a discussion with FOCA should be initiated on which class is a more suitable estimate of the aircraft properties.The applicant should provide substantiation for the chosen column in application of §2.3.1 (d) or (l) of AMC1 to Art.11 (EU) 2019/947.

In such a case of mismatch, one acceptable method is to calculate the actual critical area with EASA Critical Area Assessment Tool (CAAT), and to compare it with the nominal critical area values from the Guidelines for the Assessment of the Critical Area of an Unmanned Aircraft:

Maximum characteristic dimension (m)	⩽ 1	⩽ 3	⩽ 8	⩽ 20	⩽ 40
Nominal critical area (m^2)	6.5	65	650	6'500	65'000

6 Step #3 – Final Ground Risk Class (fGRC) Determination

	FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **3.1** to **3.4**

While Step #2 allowed to determine the intrinsic risk of a person being struck by the UAS (iGRC) in case of loss of control of the operation, this risk could now be controlled and reduced by means of mitigations (M1, M2 and M3).

For each mitigation, there is an associated relative correction factor. A positive number (e.g., +1) denotes an increase of the GRC, while a negative number (e.g., -1) results in a decrease of the GRC. All mitigations must be applied in numeric sequence to perform the assessment (i.e., M1 first, then M2, then M3).

Note: In general, a reduction of the iGRC by 1 point means a reduction of the risk of the operation by a factor of approximately 10 (i.e., 90% reduction) compared to the risk that is assessed before the mitigation means are applied. Consequently, a reduction by 2 points would imply a factor of 100 (i.e., 99% reduction).

For further details, please refer to Annex B to AMC1 to Article 11.

6.1 M1 – Strategic mitigations for ground risk

M1 refers to the planning phase of the UAS operation, where the goal is to avoid flying over people or populated areas as much as possible. This is about reducing the chance of harm by keeping the UA in areas where there are fewer people on the ground.

Typical examples of M1 mitigations arguments are:

- **Sheltering**: which refers to the use of **natural or artificial structures** to **protect people** from the UA's flight path. The goal is to shield individuals from potential UAS failures by ensuring they are **covered** or **hidden** by **obstacles** that would **reduce the likelihood of injury** if the operation becomes out of control.
- **Operational restriction**: which involves limiting the flight's operational area or adjusting the flight parameters to ensure that the UA does not fly over populated or high-risk areas. This might involve adjusting the altitude, restricting the operational area, or limiting the flight to certain times when fewer people are present.
- **Exposure**: which refers to the level of interaction or presence that people have in the operational area, and is about evaluating how exposed people are to potential risk and implementing measures to reduce this exposure (e.g., controlling or restricting public access, assessing human activity, etc.).
- **Site evaluation by data analysis or on-site evaluation**
- **Other** mitigations proposed by the applicant.

Note: As a general rule, and in particular when applying mitigation M1, the GRC cannot be reduced to a value lower than the lowest value in the applicable column in Table 2. This is because it is not possible to reduce the number of people at risk below that of a controlled area (see ref [6], §2.3.2 (d)).

6.2 M2 – Reduction of effects from ground collision

In the event of a UA crash, the kinetic energy can cause serious injury. By reducing this energy, the potential for harm is lowered. Thus, M2 focuses on **reducing the severity of injury (i.e., limit the damage or harm caused)** if the UA were to crash and hit someone on the ground. It applies to both designing the drone and ensuring safety features are in place.

Typical examples of M2 mitigations include:

- **parachute** (slowing the UA descend speed);
- **frangibility** (UA made from breakable materials that deform or shatter upon impact, reducing the force transferred to the ground);
- **impact effects analysis** (evaluation focusing on understanding the severity and extent of the consequences if the UA were to fall, crash, or have a malfunction, and aiming at identifying how to reduce these impacts through technical, operational, or environmental mitigations);
- **other** mitigations proposed by the applicant.

For further details on M2 mitigation, refer to **§B.3** of Annex B to AMC1 to Article 11.

Note: Further information on MOC Light-UAS.2512-01 can be found on [EASA's website].

6.3 M3 – An emergency response plan (ERP) is in place, the UAS operator is validated and effective

An emergency response plan (ERP) deals with the potential hazardous **secondary or escalating effects after a loss of control of the operation**. It is different from the emergency procedures, as it does not deal with the control of the UA. The ERP is used for coordinating all activities needed to respond to incidents and accidents.

<table>
<tr><td>(EU)
2014/376</td><td>Definition of an ‘accident’

‘Accident’ means an occurrence associated with the operation of an aircraft which, [..] in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down, in which

(a) a person is fatally or seriously injured as a result of: being in the aircraft, or,
- direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or,
- direct exposure to jet blast except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

(b) the aircraft sustains damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to a single engine (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, wind screens, the aircraft skin (such as small dents or puncture holes) or minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike, (including holes in the radome); or

(c) the aircraft is missing or is completely inaccessible;</td></tr>
</table>

<table>
<tr><td>(EU)
2014/376</td><td>Definition of a ‘serious incident’

‘Serious incident’ means an incident involving circumstances indicating that there was a high probability of an accident and is associated with the operation of an aircraft, which […] in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down.

A list of examples of serious incidents relevant for unmanned aicraft operations (extract from Annex to (EU) No. 376/2014):

• a near collision requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or when an avoidance action would have been appropriate,
• controlled flight into terrain only marginally avoided,
• multiple malfunctions of one or more aircraft systems seriously affecting the operation of the aircraft,
• system failures, weather phenomena, operation outside the approved flight envelope or other occurrences which could have caused difficulties controlling the aircraft,
• failure of more than one system in a redundancy system mandatory for flight guidance and navigation.</td></tr>
</table>

<table>
<tr><td>(EU)
2014/376</td><td>Definition of an ‘incident’

‘Incident’ means an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.</td></tr>
</table>

(EU) 2019/947 AMC3 UAS.SPEC.030 (3)(e)	3. Effectiveness of the ERP 3.1. For the ERP to be effective, it should: (a) be appropriate to the size, nature, and complexity of the UAS operation; (b) be readily accessible by all relevant personnel and by other entities, where applicable; (c) include procedures and checklists relevant to different or specific emergency situations; (d) clearly define the roles and responsibilities of the relevant personnel; (e) have quick-reference contact details of the relevant personnel; **(f) be regularly tested through practical exercises involving the relevant personnel**; and **(g) be periodically reviewed and updated, when necessary, to maintain its effectiveness**.
FOCA GM	Specific guidance for points (f) (g) above: The operations manual should contain clear information on the practical exercises (periodicity, personnel involved, etc.) and associated records, as well as information on the periodic review of the ERP.

2014/139 GM2 ADR.OPS.B.00 5(c)	(c) Tabletop exercises Tabletop exercises should be held at regular intervals. The aim of these exercises should be **to verify that roles and procedures are clear and understood**. These exercises offer a **good opportunity to test new or revised procedures**, before implementation, or preparation for a full-scale emergency exercise

Note: For ERP with 'medium' level of robustness, the FOCA considers that AMC3 UAS.SPEC.030(3)(e) is the acceptable means of compliance. For further guidance, please refer to the dedicated FOCA guidance for drawing up an ERP for M3 (Doc. Ref. FOCA-UAS-GM-ERP, Available on FOCA Website).

Note: ERP with 'high' level of robustness can only be justified under extra-ordinary conditions (e.g. Airshows where emergency services are on-site).

7 Step #4 – Initial Air Risk Class (iARC) Determination

	FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **4.1** to **4.5**

The Air Risk Class (ARC) is a qualitative classification of the rate at which a UAS would encounter a manned aircraft in typical generalized civil airspace. The ARC is an initial assignment of the aggregated collision risk for the airspace, before mitigations are applied. The actual collision risk of a specific local operational volume could be much different and can be addressed with the application of strategic mitigations to reduce the ARC (step #5).

Although the static generalized risk put forward by the ARC is conservative, there may be situations where that conservative assessment may not suffice. In some situations, the applicant and/or FOCA may raise the operational volume ARC to a level, which is greater than that advocated by the ARC flowchart picture. In other cases, FOCA can consult the Swiss Air Navigation Service Provider (ANSP) Skyguide to ensure that the assumptions related to the operational volume are accurate.

Note: It is important to understand that the ARC considers the **entire operational volume (flight geography and contingency volume) in both horizontal and vertical dimensions** (see Figure 6 below). During the UAS operation, the operational volume may span many different airspace environments, which is why the applicant needs to perform an air risk assessment for the entire range of the operational volume

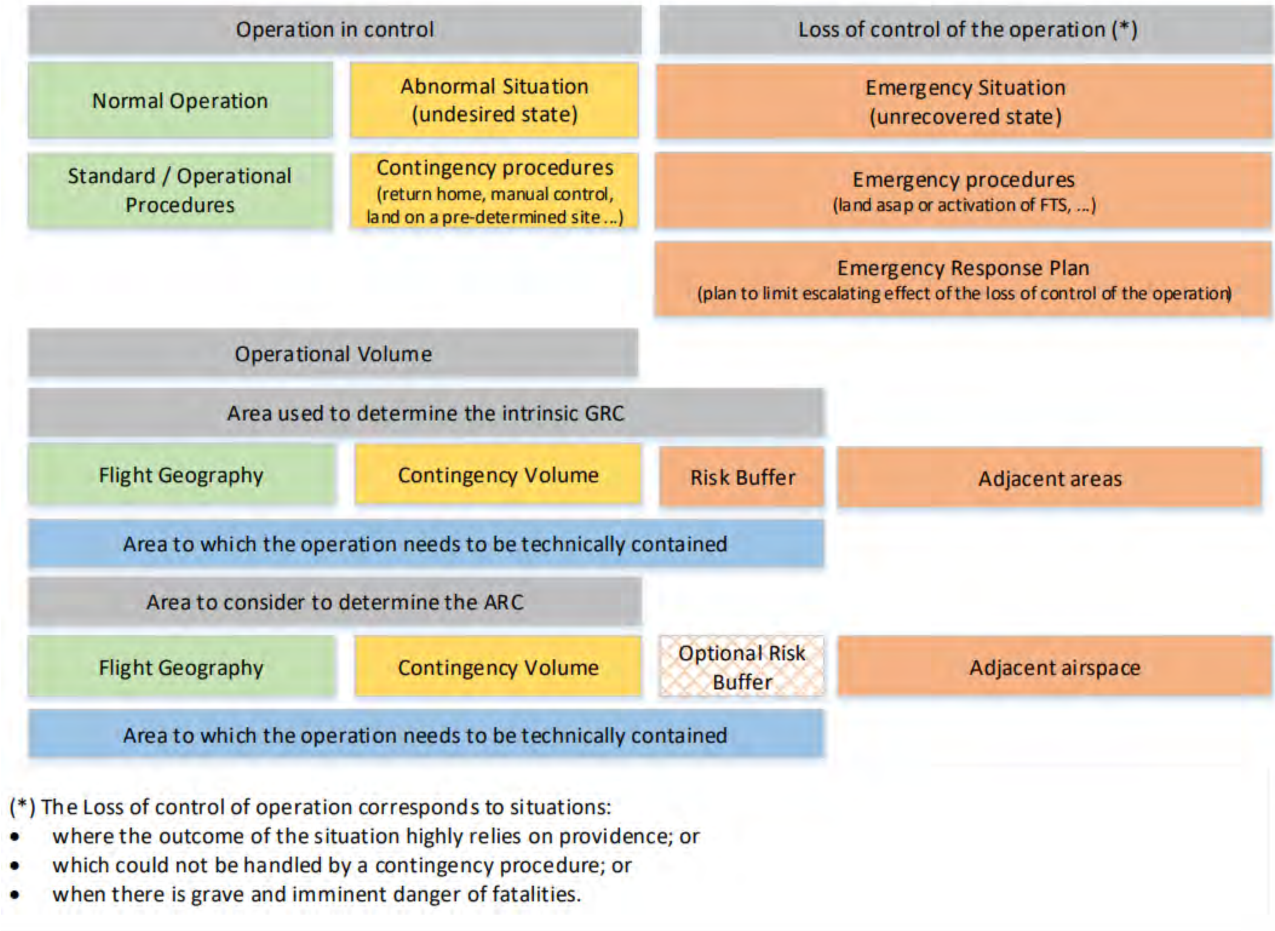


Figure 6 - SORA semantic model (Source : JARUS)

The ARC flowchart shown in Figure 7 below (equivalent to section 4.4 of the application form Part 1) can be used to determine the initial Air Risk Class (iARC).

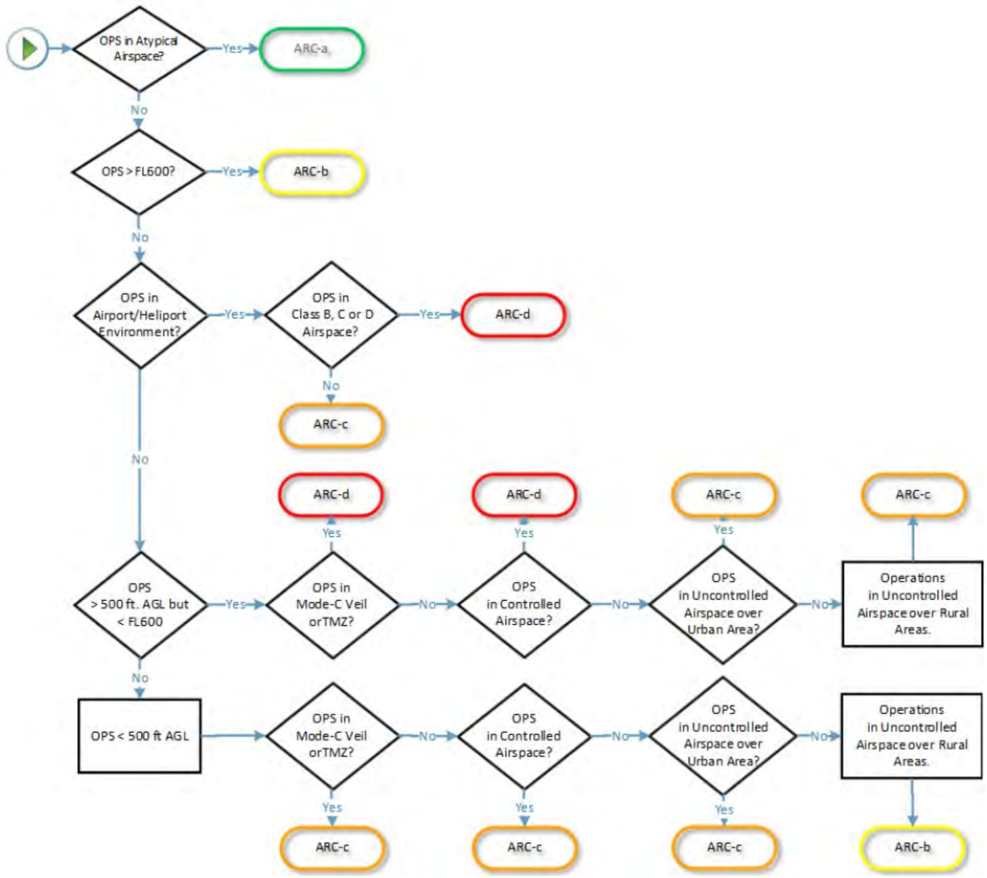


Figure 7 - ARC identification flowchart (Source: JARUS)

IMPORTANT NOTE

The actual collision risk of a specific local operational volume could be different than that identified by the flowchart and such differences can be optionally addressed with the application of strategic mitigations to reduce the ARC (step #5).

Typically, local conditions may vary and the air risk classes in Figure 7 above might not be applicable in all cases. The operator should assess the area of operation, taking into account the local conditions such as possible traffic hot-spots (gliders, paragliders, etc.) and landing places outside airports.

In particular, the identification of an ARC-b airspace must follow the considerations of Appendix V and VI of *EASA Guidelines on operations in the open and specific category* [Online Link, Issue 03 available 28.11.2025].

For flights in class E/G airspace outside of airport/heliport environment and in rural areas, ARC-b might be appropriate, but some areas may have a high density of low height traffic (VFR and glider routes, parachutes, paragliders, etc.). In that case, an ARC-c may be considered.

More extensive guidance specifically for ARC determination is available in §14, including the relevant terms and concepts for UAS operators.

Note that operations in initial ARC higher than ARC-b are considered complex and would in most of the cases require to substantiate strategic mitigations (SORA Step#5) in order to remain at a low SAIL (SAIL I-III). Higher ARCs than ARC-b require the operation to reach at least SAIL IV, whose requirements are currently more complex and effort-intensive to comply with for the majority of UAS operators.

Note: Operators planning to conduct UAS operations in a Member State other than Switzerland after receiving an operational authorization from FOCA (i.e., cross-border operations i.a.w. Article 13 of IR (EU) 2019/947) should pay particular attention if they intend to declare a residual air risk class rARC-a. The definition of ‘atypical’ airspace can vary significantly between Member States; what qualifies as ‘atypical’ airspace in Switzerland may not be recognized as such elsewhere. To avoid complications and facilitate cross-border operations, operators are encouraged to consider claiming a residual air risk class rARC-b instead, whenever feasible.

8 Step #5 – Strategic Air Risk Mitigations and residual Air Risk Class (rARC)

FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **5.1** to **5.4**

The initial ARC (iARC) identified at Step #4 (column B) is a generalized qualitative classification of the rate at which a UAS would encounter a manned aircraft (column C) in a somehow generic operational environment (column A). However, this rating may be different in the operational volume (column E).

Thus, the applicant may demonstrate that the **actual local air density rating** (column E) of the operational volume peculiar to their UAS operation is lower than the initial generalised density rating (column C) of the somehow generic operational environment in which the operation takes place.

This demonstration is the goal of Step #5, and is done through **strategic air risk mitigations**.

<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><th>Operational environment</th><th>Initial ARC</th><th>Initial Generalised Density Rating</th><th>Corresponding AEC</th><th>Actual local density rating</th><th>Residual ARC</th></tr>
<tr><td>Airport/Heliport Environment in Class C or D airspace</td><td rowspan="2">ARC-d</td><td rowspan="2">5</td><td>AEC 1</td><td>4 or 3</td><td>ARC-c</td></tr>
<tr><td>> 500ft AGL but < FL600 in a Mode-S Veil or TMZ</td><td>AEC 2</td><td>2 or 1</td><td>ARC-b</td></tr>
<tr><td rowspan="2">> 500ft AGL but < FL600 in controlled airspace</td><td rowspan="2">ARC-d</td><td rowspan="2">5</td><td rowspan="2">AEC 3</td><td>3 or 2</td><td>ARC-c</td></tr>
<tr><td>1</td><td>ARC-b</td></tr>
<tr><td>> 500ft AGL but < FL600 in uncontrolled airspace over Urban Area</td><td>ARC-c</td><td>3</td><td>AEC 4</td><td>1</td><td>ARC-b</td></tr>
<tr><td>> 500ft AGL but < FL600 in uncontrolled airspace over Rural Area</td><td>ARC-c</td><td>2</td><td>AEC 5</td><td>1</td><td>ARC-b</td></tr>
<tr><td>Airport/Heliport Environment in Class E airspace or in Class G</td><td rowspan="3">ARC-c</td><td rowspan="3">3</td><td>AEC 6</td><td rowspan="3">1</td><td rowspan="3">ARC-b</td></tr>
<tr><td>< 500ft AGL in a Mode-S Veil or TMZ</td><td>AEC 7</td></tr>
<tr><td>< 500ft AGL in controlled airspace</td><td>AEC 8</td></tr>
<tr><td>< 500ft AGL in uncontrolled airspace over Urban Area</td><td>ARC-c</td><td>2</td><td>AEC 9</td><td>1</td><td>ARC-b</td></tr>
<tr><td>< 500ft AGL in uncontrolled airspace over Rural Area</td><td rowspan="2">ARC-b[1]</td><td rowspan="2">1</td><td>AEC 10</td><td colspan="2" rowspan="2">To reduce to ARC-a, applicant demonstrates that atypical/segregated airspace requirements are met.</td></tr>
<tr><td>Operations above Flight Level 600</td><td>AEC 11</td></tr>
<tr><td>Operations in Atypical/Segregated Airspace</td><td>ARC-a</td><td>1</td><td>AEC 12</td><td colspan="2">Cannot be lower than ARC-a</td></tr>
</table>

Figure 8 – Table for ARC reduction

The table below provides additional information on strategic air risk mitigations.

FOCA GM	
Strategic air risk mitigations	
Strategic Mitigations by application of **Operational Restrictions**	Operational Restrictions are controlled by the operator and intended to mitigate collision risk prior to take-off. 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: • Mitigation(s) that bound the geographical volume in which the UAS operates (e.g. certain boundaries or airspace volumes); • Mitigation(s) that bound the operational time frame (e.g. restricted to certain times of day, such as fly only at night); • Mitigation that limit flight time or the exposure time to risk, though they may be more difficult to justify. There is some precedence for this mitigation which has (in some cases) been accepted. Therefore, even though considered difficult, this mitigation strategy may be considered. Please list any applied operational restrictions for strategic mitigations.
Strategic Mitigations by application of Common Structures and Rules	Strategic Mitigation by Common Structures and Rules requires all aircraft within a certain class of airspace 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. Most Strategic Mitigations by Common Structures and Rules will take the form of: • Common Flight Rules; • Common Airspace Structure. List any applicable Common Structures and Rules for strategic mitigations.

9 Step #6 – Tactical Mitigation Performance Requirements (TMPR)

	FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **6.1** to **6.3**

Strategic mitigations in Step #5 were applied to **reduce the ARC**. Now the residual ARC has been determined, tactical mitigations are applied to **meet residual risk of the ARC**, and this is done through TMPR.

Figure 10 below shows an overview of the air risk mitigation process, to help applicants better understand the TMPR.

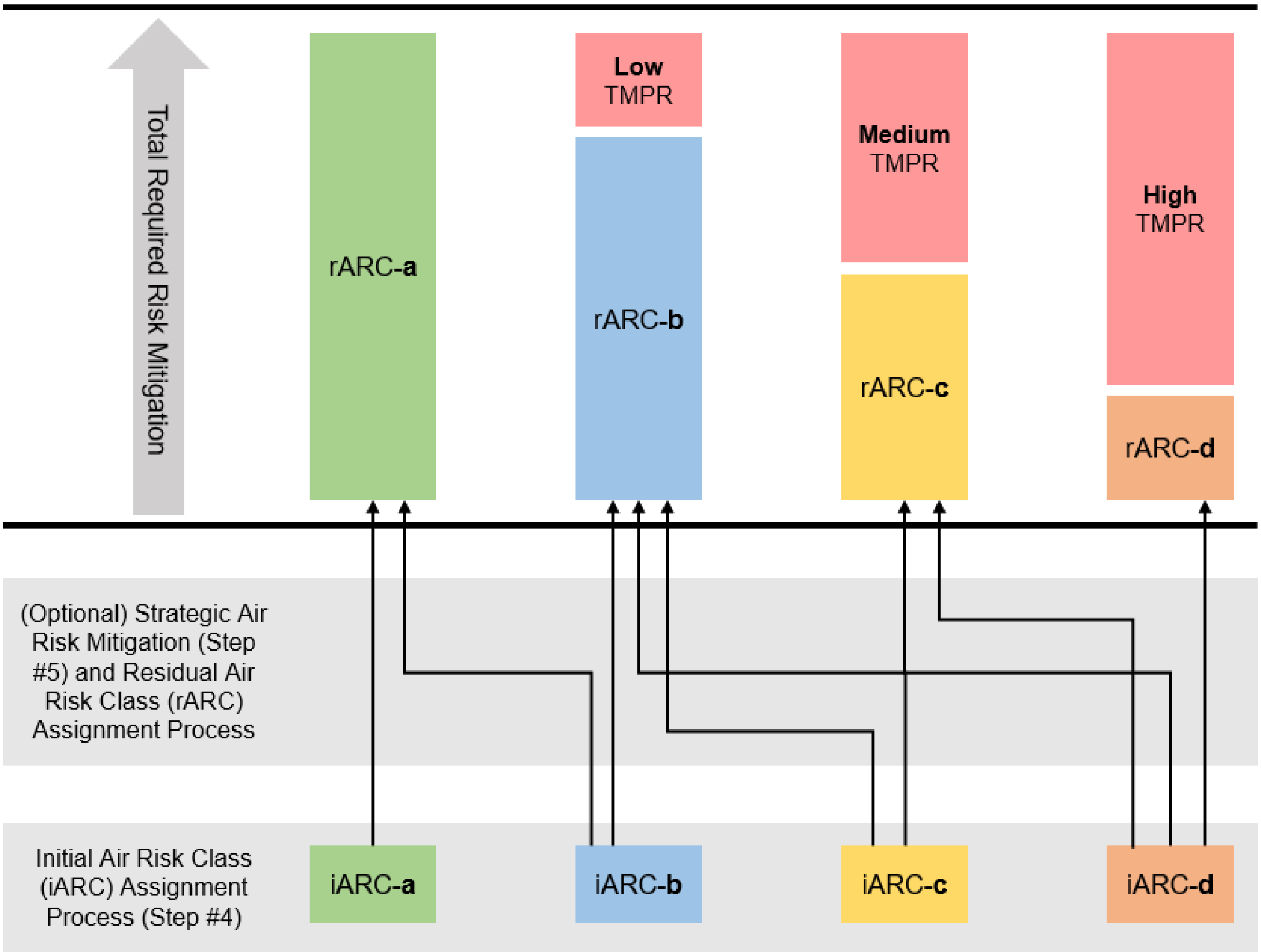


Figure 9 - The air risk process

Tactical mitigations are procedures with a very short time horizon (seconds to a few minutes) which change the UAS encounter geometry to mitigate collision risk. They are applied to mitigate any residual risk of a mid-air collision needed to achieve the applicable airspace safety objective. Tactical mitigations will take the form of either “See and Avoid” (i.e. operations under VLOS) or may require a system which provides an alternate means of achieving the applicable airspace safety objective (operation using a DAA, or multiple DAA systems).

9.1 TMPR for Operations under VLOS/EVLOS

Note: VLOS is already considered an acceptable tactical mitigation for collision risk for all ARC levels. However, 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. In general, all VLOS requirements are applicable to EVLOS. EVLOS may have additional requirements over and above VLOS. EVLOS verification and communication latency between pilot and observers should be less than 15 seconds.

Still, the applicant should have a **documented VLOS de-confliction scheme**, in which the applicant explains **which methods will be used for detection**, and define the **associated criteria applied for the decision to avoid incoming traffic**. In case the remote pilot relies on detection by observers, the use of **phraseology** will have to be described as well.

For VLOS operations, it is assumed that an observer is not able to detect traffic beyond **2 NM** (**≈ 3.7 km**). (Note that the 2 NM range is not a fixed value and may largely depend on atmospheric conditions, aircraft size, geometry, closing rate, etc.) Therefore, the operator may have to adjust the operation and /or procedures accordingly

9.1.1 VLOS Limitation

Note: This section presents an approach developed and used by the German National Aviation Authority LBA (available in german under Ref. [3], p .3).

To determine whether an operation is conducted in VLOS condition, the main factor is to ensure that the remote pilot can truly operate the UAS within visual range. To check whether an intended UAS operation is in VLOS or BVLOS conditions, the following considerations shall be made.

Any operation beyond $\boldsymbol{VLOS_{Maximum\ Range}}$, i.e. the maximum possible distance between the remote pilot location and the boundary between contingency volume and ground risk buffer is greater than $\boldsymbol{VLOS_{Maximum\ Range}}$, is considered BVLOS.

$$\boxed{\boldsymbol{VLOS_{Maximum\ Range}} = \min\left(\boldsymbol{ALOS}, \boldsymbol{DLOS}\right)}$$

Where:

- **ALOS – Attitude Line Of Sight:**
  The Attitude Line Of Sight defines the maximum distance of attitude recognition. Up to this optical limit, the remote pilot is able to control the flight path of the UAS, i.e. to determine the attitude and position of the UAS. This can be determined by flight tests.
  - For Helicopter UAV and Multicopter : $\boxed{\boldsymbol{ALOS_{max,rotorcraft}} = 327 \cdot CD + 20\ [m]}$
  - For Fixed-wing UAV : $\boxed{\boldsymbol{ALOS_{max,fixedwing}} = 490 \cdot CD + 30\ [m]}$

- **DLOS – Detection Line of Sight:**
  The Detection Line Of Sight defines the distance up to which another aircraft can be detected in time and sufficient time is available for an avoidance manoeuvre. Ground visibility (GV) is a key factor to determine DLOS.

  $$\boxed{\boldsymbol{DLOS_{max,}} = 0.3 \cdot GV}$$

  GV is dependent on the existing ground visibility at the location and time of operation (see below). However, $GV_{max} = 5km$ always applies.

- **GV – Ground Visibility:**
  The Ground visibility depends on the location and meteorological conditions and must be determined at the time of operation. The procedure for determining ground visibility must be described in the operational documentation. The use of landmarks or the use of a transmissometer are possible methods to determine GV.

  The maximum ground visibility that can be assumed is 5 kilometers, similar to the minimum flight visibility according to VFR in airspace G (VFR Switzerland RAC 4-3-4)*.

> **Note**:
> Flight visbility for manned aircraft operations in VFR can be as low as 1 500 m if flight speed ≤140 kts IAS to avoid other traffic and obstacles or in case of low probability of traffic encounters (e.g. low traffic, low level aerial work and helicopters may operate at VIS down to 800m (Ref. VFR Manual).
> In VLOS/EVLOS UAS operations, the DLOS must therefore be adapted to actual environmental conditions to allow timely detection and avoidance.

9.1.2 VLOS Deconfliction scheme

A deconfliction scheme refers to the procedures and measures implemented to prevent conflicts between the drone and other airspace users.

A proper deconfliction scheme shall detail the methods that will be applied for detection and the criteria used to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of communication phraseology, procedures, and protocols shall also be described.

Figure 11 below presents a generic example of a VLOS deconfliction scheme:

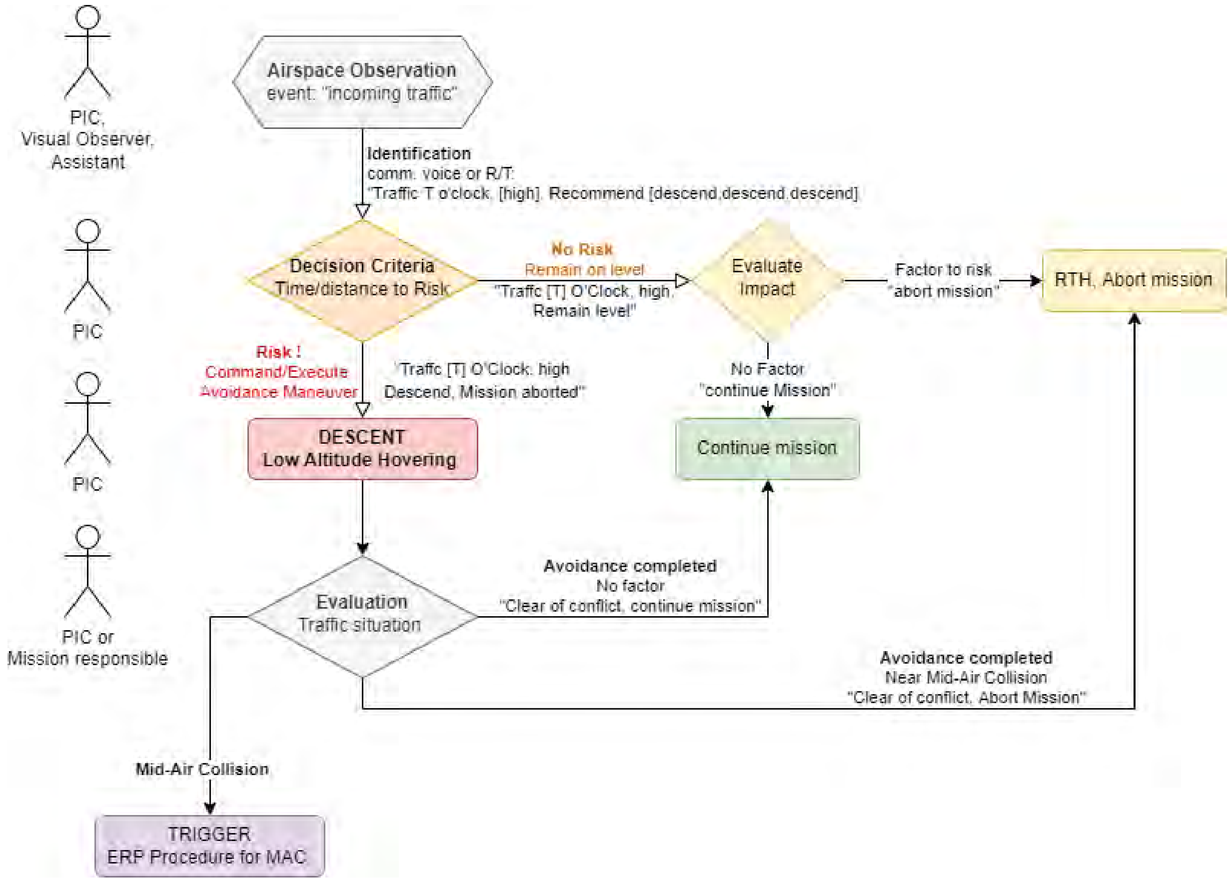


Figure 10: Generic example of VLOS deconfliction scheme

Based on this scheme, Table 4 below desribes its elements and responsible crew members:

Gate	Description	Responsible
Airspace Observation	On-going VLOS procedure to observe surrounding airspace and make the entire crew aware of any traffic in the area.	Crew: • PIC • VO • Assistant
Decision Criteria	Decision criteria: if the incoming traffic is detected at [D] km or less and at [XYZ] ft or less from UA position (or [XYZ] ft/AGL), the avoidance manoeuvre should be initiated. Note: Maximum time from observation to information shall not exceed 2 seconds.	PIC
Avoidance Maneuver	Descend to the lowest possible altitude while crew is maintaining VLOS. Reaction Time until triggering avoidance manoeuvre is commanded does not exceed [S] seconds. Time between start of descend at maximum operating altitude of [XYZ] ft to safe altitude of [XY] ft approximately [M] Minutes.	PIC
Evaluate impact	Assess factor to risk. If on-going risk: • Return to home at low altitude, maintain VLOS, or • Land at a defined safety landing area.	PIC

Evaluation of Traffic situation	Evaluate recovery of situation: • Incoming aircraft is leaving the operation area of the UA, clear of conflict, no further risk present; • UA has landed safely; • Near Mid Air Collision: abort mission and file occurrence; • Mid-Air Collision: Trigger ERP.	• PIC • Mission resp.

Table 1: Example Procedure and Gate VLOS De-confliction scheme

9.1.3 EVLOS Specificities

In general, all VLOS requirements are applicable to EVLOS. However, when operating in EVLOS, the required detection volume and alerting thresholds must be carefully defined, taking into account the following key factors:

- **Closing speed of potential conflicting traffic:** the detection volume should account for the worst-case scenario of fast-approaching traffic. For example, a HEMS helicopter flying at low altitude can rapidly enter the operational area. Typical cruise speeds include 80 m/s for an AW109 and 68 m/s for an E145.
- **Reaction time of the remote pilot:** the time required for the remote pilot to recognize a conflict and initiate an avoidance maneuver must be considered. While a standard reaction time is typically set to 5 seconds, EVLOS operations introduce additional delays due to the necessary communication between the remote pilot and the observer(s).
- **System response time and aircraft performance:** the time needed for the UAS to execute an avoidance maneuver depends on its performance characteristics. For instance, the descent time from the maximum operational height must be considered, particularly when performing rapid descent maneuvers at the maximum descent rate.
- **Detection volume vs. alerting threshold:** the detection volume must be significantly larger than the alerting threshold (the point at which the remote pilot or observer decides to initiate avoidance action). Several factors influence this, including:
  - the relative positions of the drone, the remote pilot and observer(s);
  - meteorological conditions that may impact visual detection (e.g., visibility, obstacles, lighting conditions, background contrast, or other environmental effects);
  - a clearly defined visibility center, which includes the minimum required visibility from both the drone's position and the locations of the remote pilot or observer(s);

9.2 TMPR for Operations under BVLOS

The alternate means of compliance with the human 'see and avoid' requirements (applicable for VLOS/EVLOS operations) is loosely described as 'detect and avoid (DAA)'. DAA can be achieved in several ways, e.g. through ground-based DAA systems, air-based DAA systems, or some combination of the two. DAA may incorporate the use of various sensors, architectures, and even involve many different systems, a human in the loop, on the loop, or no human involvement at all.

Note: For TMPR for operations under BVLOS, please refer to (EU) 2019/947 Annex D to AMC1 to Article 1, and especially §D.5.3.2 "TMPR qualitative criterion table" and §D.5.4 "TMPR robustness (integrity and assurance) assignment".

IMPORTANT NOTE

BVLOS flights, in particular in uncontrolled, non-segregated airspace, without airspace observers, and even in VLL below 500 m (AGL) require a comprehensive analysis of the expected manned traffic in the area of operation (see **guidance is available in §14**).

Also due to the uncertain equipage rate of manned aircraft registred in Switzerland and sharing the swiss airspace, relying solely on one single technology (e.g. ADS-B receiver) may not be sufficient to claim appropriate detection of the manned traffic to meet the TMPR, unless relevant supporting data are provided to FOCA.

10 Step #7 – Specific Assurance and Integrity Level (SAIL) determination

	FOCA-UAS-APP-SORA-Part1 – Part **C** – Sections **7.1** to **7.2**

The SAIL (from SAIL **I** to SAIL **VI**) is determined as a combination between the final ground risk class (fGRC) and the residual air risk class (rARC). It represents the level of confidence that the operation will remain in control, and determines the level of robustness for the operational safety objectives (OSOs – Step #8).

		Residual Air Risk Class (rARC)			
		rARC-**a**	rARC-**b**	rARC-**c**	rARC-**d**
Final Ground Risk Class (fGRC)	< 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	Certified Category			

Note: Compliance to SAIL III or higher robustness will require in-depth supporting evidence from the UAS manufacturer. This can be supplied in the form of:
- EASA Design Verification Report (DVR); or
- compliance to EASA Functional Test Based means of compliance with SC Light-UAS; or
- compliance to applicable aviation standards for safe design.

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

	FOCA-UAS-APP-SORA2.0-P2 & SORA Compliance Spreadsheet

A threat is defined as an occurrence that in the absence of appropriate threat barriers can potentially result in the hazard (i.e., UAS operation being out of control). The holistic risk model (HRM) identifies five generic categories of threats, potentially applicable to any UAS operation:

- technical issue with the UAS;
- human error;
- aircraft on collision course;
- adverse operating conditions;
- deterioration of external systems supporting the UAS operation.

Possible threat barriers have been identified and associated with the five generic categories of threats. Each of these threat barriers reduce the likelihood of the hazard "UAS operation out-of-control" by preventing the threat from developing into the hazard, or by reducing the likelihood of the threat.

To better understand the link between the SAIL and the associated OSOs levels of robustness, it is important to note that the effort to perform this step of the risk mitigation needs to be proportional to the risk of the operation while considering the implemented harm barriers. For example, it is clear that by operating over unpopulated areas, the risk of hitting third parties on the ground is mitigated by an extreme application of the harm barrier of population density. In such a case, as the risk is already fully mitigated by the use of harm barriers, minimal effort should be required in implementing threat barriers. On the contrary, an operation conducted over crowded areas is likely to have a very high intrinsic risk thus requiring significant effort on reducing the likelihood of the hazard.

There are 3 robustness levels: Low, Medium and High. The robustness designation is achieved using both the **level of integrity** (i.e., safety gain) provided by each mitigation, and the **level of assurance** (i.e., method of proof) that the claimed safety gain has been achieved.

LOW level of assurance

A **LOW** level of assurance is where the applicant **declares** that the required level of integrity has been achieved.

Examples of self-declaration:

- *[Operator XYZ] declares that the required level of integrity for the Strategic Mitigations for Ground Risk has been achieved (Criterion #1 and/or Criterion #2 as applicable for low robustness mitigations).*
- *[Operator XYZ] declares that the required level of integrity of [OSO #6 - C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation]: has been achieved.*

MEDIUM level of assurance

A **MEDIUM** level of assurance is where 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 level of assurance

A **HIGH** level of assurance is where the achieved integrity has been found acceptable **by a competent third party**.

Important Note:
When submitting a request for Operational Authorization, the applicant must follow the levels of integrity and assurance according to the applicable SORA methodology (JARUS SORA or AMC to Art.11 of the UAS Regulation (EU) 2019/947).

In cases where more documentation has been provided than required by the SORA methodology, **it should not be considered as verified by FOCA and the content remains solely under the responsibility of the applicant/operator.**

Note: For further guidance, please refer to guidance material available on FOCA website.

12 Step #9 - Adjacent area / airspace considerations and containment requirements

FOCA-UAS-APP-SORA2.0-P1 – Part **C** – Sections **9.1** to **9.5**

The objective of Step #9 is to address the risk posed by a loss of control of the operation, resulting in an infringement of the adjacent area on the ground (i.e., ground area adjacent to the ground risk buffer, where it is reasonably expected a UA may crash after a loss of control situation resulting in a flyaway), and/or adjacent airspace (i.e., airspace adjacent to the operational volume, where it is reasonably expected that a UA may fly after a loss of control situation resulting in a flyaway).

There are several potential failure types that could lead to a loss of control situation resulting in a flyaway (GPS failure, internal navigation system failure, remote pilot error, etc.). These potential failures need to be mitigated by **containment requirements**.

The SORA 2.0 distinguishes between two different versions of containment: **“basic”** containment and **“enhanced”** containment, with requirements associated to each of them. To assess which type of containment applies, considerations regarding adjacent areas and adjacent airspaces are required.

12.1 Adjacent area definition

Consider areas on the ground at most **1 km away** from the operational volume.

A more detailed definition of the adjacent volume can be computed based on the relevant tool from AESA [4], 'Max Cálculo Área Adyacente Excel Ed.1.xlsx' [Online Link, Available 01.11.2023].

To assess the type of adjacent area (sparsely populated, populated, gathering), refer to §5.3.

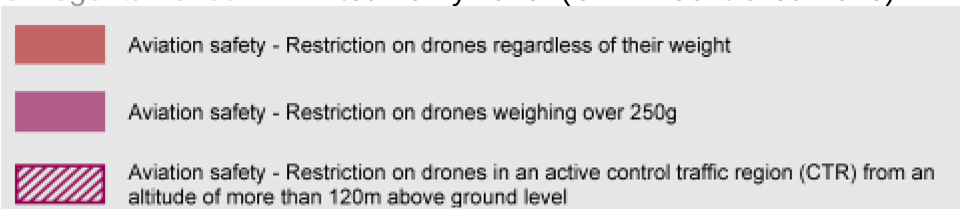
Note: An adequate procedure must be in place in operations manual to assess the true nature of the adjacent area prior to each flight or operation.

12.2 Adjacent airspace definition

For the assessment of adjacent airspace, identify what type(s) of airspace is(are) immediately touching the edge of the operational volume (i.e. normally touching the edge of contingency volume).

Refer mainly to the 'UAS Geographical Zones of Switzerland' depicted on the "restrictions for drones" layer of map.geo.admin.ch and established for Aviation Safety purposes:

- Red zones – "Prohibited area" (airspace reservation/restriction for special use)
- Solid Magenta Zones - "No-Fly zone" (airport, heliport and aerodrome environment)
- Striped Magenta Zones - "Limited no-fly zone" (CTR – Controlled Zone)



To assess the type of adjacent airspace (incluing e.g., TMAs, airspace class C) please consult the ICAO Chart and the Glider Chart.

12.3 FOCA Alternative Means of Compliance (MoC) to Step #9

On 1st January 2023, FOCA has issued an Alternative Means of Compliance (AltMoC, EASA Reference #2023-00006) intended to change the containment requirements and the assessment of their need as found in chapter 2.5.3 Step 9 of AMC1 to Article 11 of (EU) 2019/947, referring to the JARUS Specific Operations Risk Assessment (SORA) V2.0 methodology. The details of this AltMoC are available on the following link: *FOCA UAS AltMoC to SORA Step 9 on Containment [online link] Available (28.11.2025)*.

With this AltMoC, if any of the 4 following triggers is true for an operation, enhanced containment requirements apply. If not, basic containment requirements apply. • Where a large assembly of people (~20,000 ppl or more) is present within 1km distance from the operational volume, unless already approved for operations over assemblies of people. *Applicant must have a procedure in place to check this before each operation.* • Where adjacent areas are populated areas, and: – M1 mitigation of Medium or High robustness has been applied, unless the mitigation applies also to adjacent areas; or – operation is conducted over a controlled ground area. • Height of the operational volume is above 150m altitude AGL, where adjacent airspace is ARC-d. ATC or Competent authority permit is needed before the operation. • With an UAS larger than the 3m class flown in airport environment

12.4 Technical requirements for 'basic' containment

'Basic' containment applies to all operations regardless of what is included in the adjacent areas. According to FOCA AltMoC, the technical requirements for 'basic' containment are:

No probable[2] failure[3] of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume. *[Guidance] 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);* • *any relevant particular risk (e.g. hail, ice, snow, electro-magnetic interference…) associated with the ConOps.*

Evidence for showing compliance to these requirements should include an analysis of the UAS's probable failure types and a design and installation appraisal showing how these failures will not lead to a fly-away into the adjacent area/airspace.

The probable failures of the unmanned system leading to operations outside of the operational volume should be identified by the applicant. A notional Failure Mode and Effect Analysis (FMEA) containing functions, their mode failure rate (qualitatively) and their failure effect is sufficient in this context.

Examples of failure types that could lead to operation outside of the operational volume are typically but not only:

- GPS/GNSS failure;
- compass failure;
- C2 Link loss in the case of unlicensed frequencies;
- autopilot failure;
- propeller/Motor failure;
- remote Control Failure;
- human error.

The operator should ideally refer to the documentation from the UA manufacturer or design organisation to substantiate how the above-mentionned failures are not probably going to lead to a fly-away for their operations.

12.5 Technical requirements for 'enhanced' containment

'Enhanced' containment applies to operations where one of the triggers in §12.3 is true for the operation (higher risk involved). According to FOCA AltMoC, the technical requirements for 'enhanced containment are:

(a) The UAS is designed to standards that are considered adequate by the competent authority and/or in accordance with a means of compliance that is acceptable to that authority such that: 1. The probability of the UA leaving the operational volume shall be less than 10^{-4}/FH. 2. No single failure[4] of the UAS or any external system supporting the operation shall lead to operation outside of the ground risk buffer. *Compliance with the requirements (a) 1. and 2. above shall be substantiated by analysis and/or test data with supporting evidence.* (b) Software (SW) and Airborne Electronic Hardware (AEH) whose development error(s) could **directly**[5] lead to operations outside of the ground risk buffer shall be developed to an industry standard or methodology recognized as being adequate by the competent authority.

[2] 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."

[3] 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 as failures. 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.

[4] Same definition of failure as footnote 3 above.

[5] Requirement (b) does not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the competent authority. The use of the term 'directly' means that a development

Compliance to <u>all 3 criteria</u> must be shown to fullfil the enhanced containment requirements.

12.5.1 Criterion 1: Probability(leavingOV) < 10^{-4}/FH

Reminder: Operational volume = flight geography + contingency volume.

This first requirement (a) 1. should be addressed using either a quantitative or qualitative safety assessment method. The objective is to quantify the probability of occurrence of the top event: “leaving operational volume” and/or demonstrate protection through failsafe design.

Examples:

- fault Tree Analysis, i.e. top-down analysis with the goal to quantify probability of occurrence for the top event named “UA leaves the operational volume”;
- functional Hazard Analysis to identify failure conditions/top events[6].

A commercial off the shelf (COTS) UAS failure rate of 10^{-2}/FH is assumed. Further data is required to substantiate higher reliability figures.

12.5.2 Criterion 2: No single failure shall result in operation outside of ground risk buffer

The second requirement (a) 2. should be addressed using a Failure Mode and Effect Analysis (FMEA) similar as for ‘basic’ containment, at component and/or functional level:

- functions/items, failure mode, failure rate (qualitatively), failure effect;
- address single failures leading to operation **outside of the ground risk buffer** (e.g., geo-fencing failure).

Item	Failure mode	Failure Causes	Failure Effects	Failure Rate	Detection Method
Example					
FCU	FCU Malfunction	SW/electrical malfunction	- Loss of control - Crash - Fly away	…	….

As for ‘basic’ containment, the typical failures to be considered (not exhaustive) are listed above in §12.4.

12.5.3 Criterion 3: Software (SW) and Airborne Electronic Hardware (AEH) Development Errors

As given in Note 2 to AMC1 Art. 11 (EU) 947, §2.5.3(c), Requirement (b): “*[This requirement] does not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the competent authority. The use of the term ‘directly’ means that a development error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for another system to prevent the UA from exiting the operational volume.*”

At the time of writing this GM, an acceptable standard for compliance with the third requirement is being developed by industry standardization bodies (e.g., EUROCAE). In the absence of an acceptable standard the applicant is advised to show that a SW or AEH failure cannot *directly* lead to operations outside of the ground risk buffer. Design and architectural considerations supported by common cause analysis are adequate to this scope.

12.6 FOCA’s guidance on compliance with ‘enhanced’ containment requirements

‘Enhanced’ containment can be fulfilled most commonly either by having a tether of sufficient strength or an ***independent*** Flight Termination System (FTS) which can also be fulfilled by an independent parachute system in which case the M2 mitigation can be used to fulfil the ‘Enhanced’ containment.

The FTS should allow the remote pilot to prevent the UA from exiting the ground risk buffer. Thus, the FTS should force the descent of the UA and prevent it from continuing its unintended trajectory (e.g. by

error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for another system to prevent the UA from exiting the operational volume.

[6] Refer to EUROCAE, ED-279, Generic Functional Hazard Assessment (FHA) for UAS/RPAS for further guidance on FHA.

cutting the propulsion power) and also avoid a single failure in the UA disabling the activation of the FTS. Therefore, the activation system is required to be independent from the on-board automatic flight control and guidance system of the UA.

With the installation of an independent FTS, substantiation to criterion #3 is also considered fulfilled.

If the FTS is ***not independent***, then an FMEA (Failure Modes and Effects Analysis) is required to justify no single failure can lead to fly-away into adjacent areas/airspace. The FMEA analysis will this time focus on the single failures leading to operation outside of the ground risk buffer (e.g. Geofencing failure).

When applicable, compliance with EASA Means of Compliance with Light-UAS.2511 (MOC Light-UAS.2511-01) should be demonstrated/declared.

➔Final MOC Light-UAS.2511-01 - Issue 01, 05 May 2022, [online link, accessible 01.11.2023]

For all other design and systems, compliance to AMC1 Art. 11 (EU) 947, §2.5.3(c) shall be demonstrated based on supporting evidence provided by the applicant. An EASA Design Verification Report may be required.

13 Guidance on the necessary volumes for the risk assessment

13.1 Volumes presentation

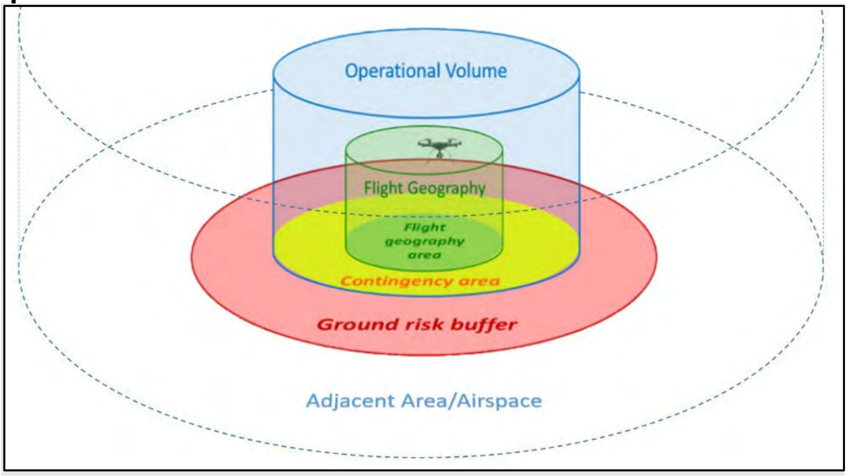


Figure 11: Volumes presentation based on SORA 2.0 semantics

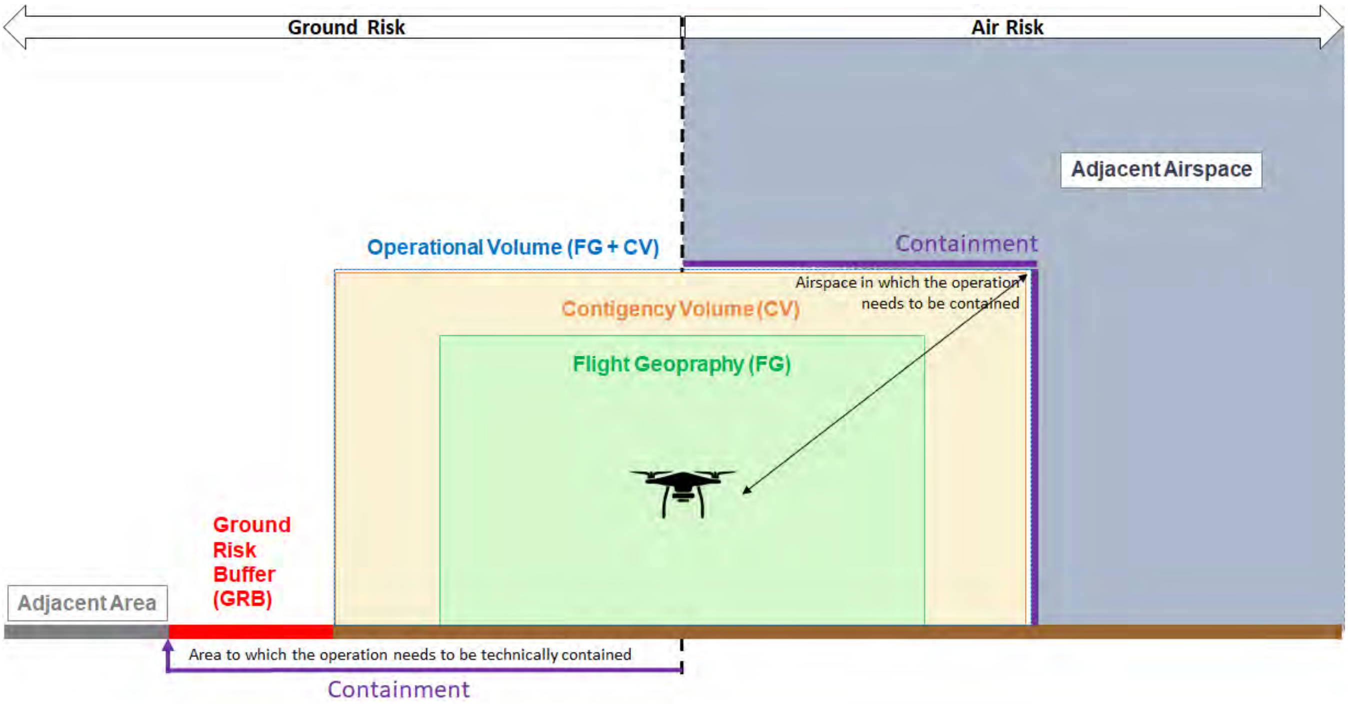


Figure 12: SORA Semantic Model

Note: the optional Air Risk Buffer is not shown, but can be defined by the operator. The operation needs to be contained in the air and over the ground:

in the air: in the operational volume;

over the ground: in the operational volume and ground risk buffer.

13.2 Volumes definitions

13.2.1 Operational volume (OV)

(EU) 2019/947 GM1 Article 2(32)	The 'operational volume' includes the 'flight geography' and the 'contingency volume'. To define the operational volume, the UAS operator should consider the position-keeping capabilities of the UAS in a 4D space (latitude, longitude, height, and time). The accuracy of the navigation solution, the flight technical error of the UAS, as well as the path definition error (e.g. map error) and latencies should be considered and addressed in defining the operational volume. For navigation errors: the UAS operator should take into account that such errors are determined by the interaction of several contributes, like positioning sensors providing position, navigation and flight control systems, system and human latencies, and environment. The UAS operator should therefore establish sufficient margins to cater for such errors.

FOCA GM	The operational volume is defined as the volume in which the operation takes place safely. The operational volume (OV) consists of the Flight Geography (FG) and the Contingency Volume (CV). Please refer to the defintions of FG and CV below.

13.2.1.1 Flight geography (FG)

(EU) 2019/947 GM1 Article 2(28, 29)	The 'flight geography' is the spatially and temporally defined volume of airspace in which the UAS operator plans to conduct the operation under normal procedures; the projection of such volume on the surface of the Earth constitutes the 'flight geography area'. Additionally, the UA positioning errors must be accounted for in the definition of this area.

FOCA GM	The Flight Geography is the volume in which the operator is conducting a mission under normal operating conditions. Depending on the type of the mission the FG can be defined as a flight corridor for each planned trajectory or as a larger volume to allow for a multitude of similar missions with changing flight paths.

13.2.2 Ground Risk Buffer (GRB)

(EU) 2019/947 GM1 Article 2(23)	The 'ground risk buffer' is the area on the surface of the Earth surrounding the operational volume, which is defined by the UAS operator to minimise the risk to third parties on the surface in case the UA leaves the operational volume (i.e. the area the UA is expected to impact if its FTS is triggered when the UA leaves the operational volume).

FOCA GM	The Ground Risk Buffer (GRB) is an an area on the ground outside the operational volume. The GRB can be understood as a safety margin: If the operator looses control of the UA, the subsequent crash shall be contained within the area of OV + GRB. The GRB is therefore specified in order to minimize the risk to third parties on the ground in such an event. The size of the GRB should be such that any event to terminate the flight shall end with the crash of the UA within the ground buffer and not outside. The distance covered by the UA during an Emergency Procedure should be taken into account to size the GRB.
Note 1: The definition of the ground risk buffer used in this document follows (EU) 2019/947 AMC, section B.2 on M1 – Strategic mitigations for ground risk, (1) Generic criteria for low robustness: A	

ground risk buffer with at least a 1:1 rule or, for rotary wing UA, defined using a ballistic methodology approach acceptable to the competent authority (see Appendix 2 for further guidance)

Note 2: The area in which the operation needs to be technically contained is FG + CV + GRB. Therefore, to determine the ground risk class, the area of Flight Geography and Contingency Volume projected onto the ground and the area of the Ground Risk Buffer must be taken into account. The highest ground risk class occurring in the entire area is assumed for the SORA. For instance, if only the GRB is in a "populated area", the entire operation is still to be assessed as an operation conducted above a "populated area".

13.2.3 Adjacent area and adjacent airspace (ADJ)

The adjacent area is the ground area adjacent to the ground risk buffer where it is reasonably expected a UA may crash after a loss of control situation resulting in a flyaway.

The adjacent airspace is airspace adjacent to the Contingency Volume where it is reasonably expected that the UA may fly after a loss of control situation resulting in a flyaway.

The extent of the adjacent area/airspace depends on the particular aircraft performance and the resulting likelihood of flying into an area with an increased risk (i.e., a higher intrinsic air/ground risk than in operational volume). "An infringement of the adjacent areas on the ground and/or adjacent airspace" is defined as "a loss of containment", i.e., a breach of the outer boundary of the risk buffer.

Containment is ensured through compliance with ‘basic’ or ‘enhanced’ containment requirements.

Best practice to determine the ADJ size:

- 1km distance from the operational volume.
- Assess the area with respect to assemblies of people, populated areas, airports, heliports, airspace.

13.3 Volumes calculations

This section presents an approach initially developed and used by the German National Aviation Authority LBA (available in german under Ref. [3], p. 3).

Below, semantic models (side view and top view) intend to support the applicant in visualizing the different volumes and their calculations presented in this section.

Any alternative approach or deviation from these calculations guidelines can be used providing sufficient substantiation (e.g., based on flight mechanics and a higher accuracy of sensors).

Note: Please refer to §13.4 for practical examples.

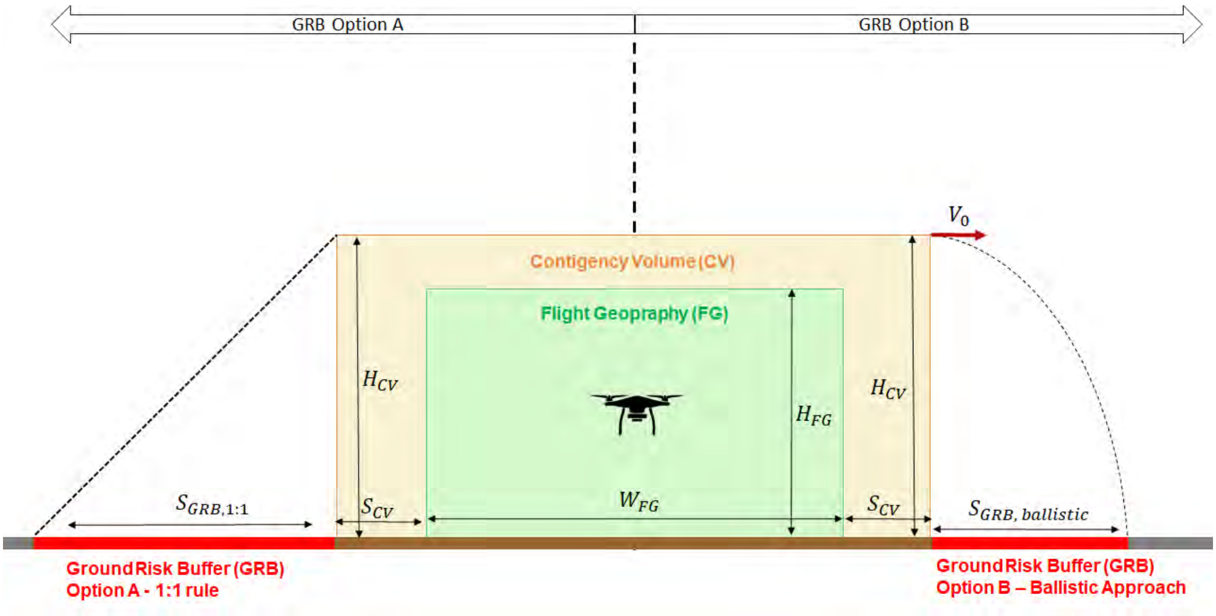


Figure 13: Detailed Semantic Model - Side View

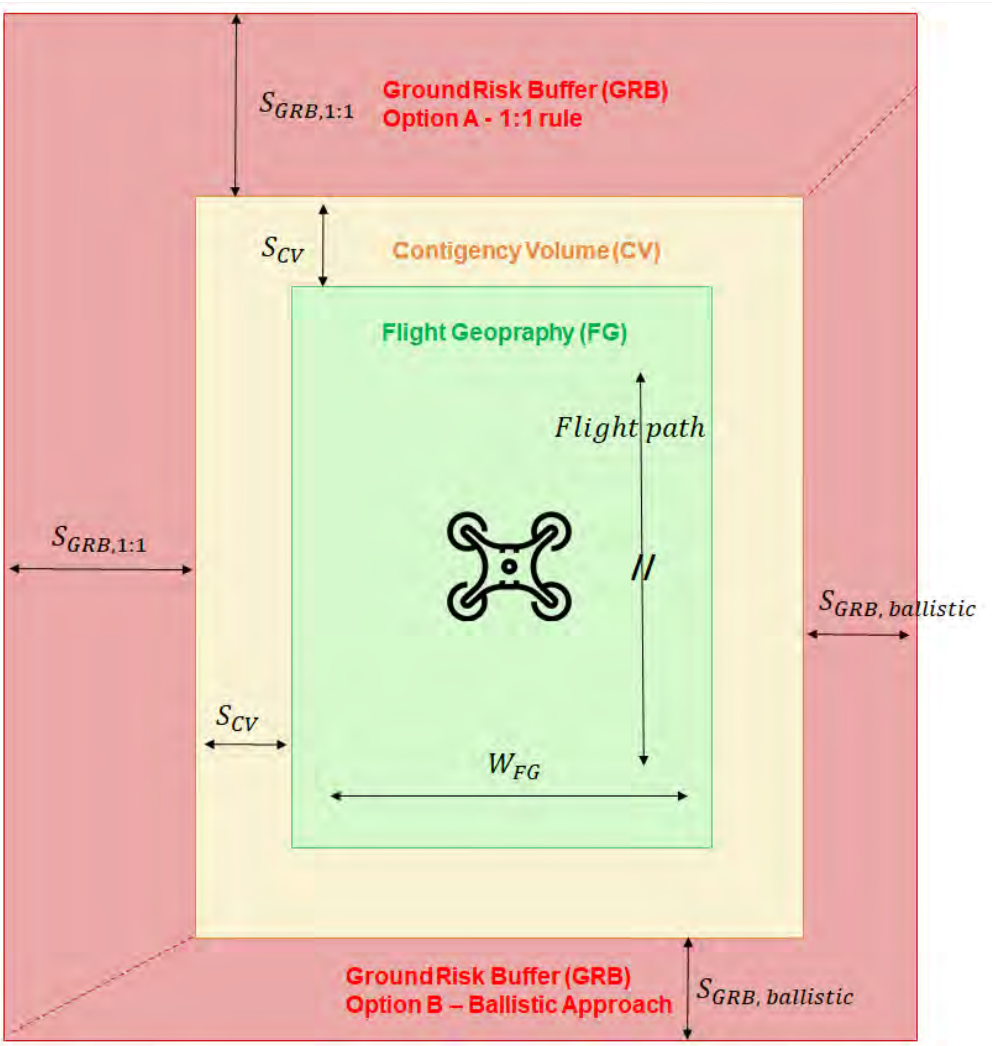


Figure 14: Detailed Semantic Model - Top view

Based on the semantic model above, the following table provides preliminary information on the parameters:

Parameter	Unit	Definition
V_0	m/s	**Maximum cruise speed** • The normal maximum structurally safe cruising speed (also known as V_{NO}) • Typically used values: o for a fixed wing UA: V_0 shall be ≥ 1.25 x $V_{Stall,clean}$ o for a multirotor UA: V_0 shall be ≥ 3 m/s **Note:** The maximum operating speed in a given flight mode can also be used as reference (e.g., "P", "C", "N" etc. modes), provided that this mode is "hard-coded".
CD	m	**Maximum characteristic dimensions** Ref to §3.2 where CD is defined
V_W	m/s	**Maximum sustained wind** Maximum allowed wind speed specified in the operations manual up to which the UAS may be operated.
H_{FG}	m	Height of the flight geography (vertical extent)
W_{FG}	m	Width of the flight geography (lateral extent)
H_{CV}	m	Height of the contingency volume (vertical extent)
S_{CV}	m	Size of the contingency volume (lateral extent)
S_{GRB}	m	Size of the ground risk buffer (lateral extent) *Note: The GRB being a surface, it does not have a height.*

13.3.1 Calculation of flight geography (FG)

- W_{FG} must be sufficient to conduct the operation in nominal conditions;
- H_{FG} is usually the maximum operating height/altitude (e.g., 120 m AGL).

Both W_{FG} and H_{FG} shall <u>at least</u> be equal to 3 times the characteristic dimensions (CD) of the UAS :

$$\mathbf{W_{FG} \geq 3 \times CD\ [m]} \quad \text{and} \quad \mathbf{H_{FG} \geq 3 \times CD\ [m]}$$

Depending on the nature of the flight geography, there are 2 recommended options to design it.

- **Option A** – The flight geography is a selected flight route
  - ⇨ The size of the flight geography usually results from the operator's intended flight area / flight route.
  - ⇨ The operator should perform a forward IN-OUT planning.
- **Option B** – The flight geography is the maximum available area when operating over a controlled ground area
  - ⇨ The ground projection of flight geography, contingency volume and also the ground risk buffer must be completely contained in the controlled ground area.

⇨ The operator should perform a backward OUT-IN planning:

- o Ground Risk Buffer: The outer boundary of the ground risk buffer is first subtracted from the topology of the controlled ground area. This results in the boundary between contingency volume and ground risk buffer.
- o Contingency Volume: the lateral extent (width) of the contingency volume is subtracted from this boundary.
- o The remaining area is the maximum possible extension of the flight geography. Please note the remark on the minimum extent of flight geography above.

13.3.2 Calculation of contingency volume (CV)

To calculate the dimensions of the contingency volume, two approaches may be used.

Conservative approach (rule of thumb): $\boxed{\mathbf{S_{CV} = H_{CV}} = 10 \text{ seconds} \times \text{cruise speed } (V_0)}$

Detailed approach: In the following, a detailed approach explains how to calculate both S_{CV} and H_{CV}.

$\mathbf{S_{CV}\ [m] = S_{GPS} + S_{POS} + S_{MAP} + S_{RT} + S_{CM}}$		
Components of S_{CV}		Values
$\mathbf{S_{GPS}}$	GNSS Accuracy (can be reduced to precise value with DGPS – e.g.,RTK)	$S_{GPS} = 3$ m
$\mathbf{S_{POS}}$	Position hold error	$S_{GPS} = 3$ m
$\mathbf{S_{MAP}}$	Path definition/Map error	$S_{MAP} = 1$ m
$\mathbf{S_{RT}}$	Reaction distance (lateral distance covered during reaction period)	With manual triggering* of contingency procedures: $\mathbf{S_{RT}}$ [m] $\mathbf{= V_0 \times T_{RT}}$ V_0 : speed of the UA [m/s] T_{RT} : reaction time [s] **Commonly used value: 1 s** * S_{RT} can be claimed smaller when operating fully automated contingency measures/systems (e.g. geo-fencing).
$\mathbf{S_{CM}}$	Contingency Maneuver	**a)** For Multirotor/Heli – «Hover»/Stop maneuver Assumptions: – Pitch angle θ, with $\theta_{max} \leq 45°$ – Thrust to weight ratio ≥ 2 The minimum distance to transition into hover is defined as: $\boldsymbol{S_{CM} = \frac{1}{2}\frac{V_0^2}{g\ \tan(\theta)}}$ **b)** For Fixed-Wing – U-Turn Curve Assumption: Roll angle $\phi_{\max} \leq 30°$ The radius of the U-Turn curve is defined as: $\boldsymbol{S_{CM} = \frac{V_0^2}{g\ \tan(\phi)}}$ **c)** Using of parachute when leaving FG

		If flight is terminated by triggering a parachute directly when leaving the FG: **$S_{CM} = V_0 \times t$** With t : time until parachute deployment [s]

H_{CV} [m] = H_{FG} + H_{BARO} + H_{RT} + H_{CM}		
Note: For operations in Very Low Level airspace – VLL (i.e. < 150 m AGL), it is always recommended to keep a reasonable buffer (contingency volume) between the flight geography and 150 m AGL, even if this contingency volume might slightly exceed the 150 m AGL limit.		
Components of H_{CV}		Values
H_{FG}	Height of the flight geography	As determined by the operational needs
H_{BARO}	Altitude measurement error	H_{BARO} = 1 m for barometric measurement H_{BARO} = 4 m for GPS-based measurement
H_{RT}	Reaction height (vertical distance covered during reaction period)	With manual triggering* of contingency procedures: **a)** <u>For Multirotor/Heli – «Hover»/Stop maneuver:</u> **H_{RT} [m] = $V_Y \times T_{RT}$** V_Y : maximum climb rate of the UAS [m/s] T_{RT} : reaction time [s] **Commonly used value: 1s** **b)** <u>For Fixed-Wing – U-Turn Curve:</u> Considering the UA flying at V_0, with a climb angle of 45°, the distance covered during reaction period is: $H_{RT} = \frac{\sqrt{2}}{2} \cdot V_0 \cdot T_{RT} = V_0 \cdot 0.7 \cdot 1s\,[m]$ * H_{RT} can be claimed smaller when operating fully automated contingency measures/systems (e.g. geo-fencing).
H_{CM}	Height of the contingency maneuver	a) <u>For Multirotor/Heli – «Hover»/Stop maneuver:</u> Assumption: The kinetic forward energy is completely converted into potential energy: $H_{CM} = \frac{1}{2}\frac{V_0^2}{g}$ b) <u>For Fixed-Wing – U-Turn Curve</u> Assumption: UA exits the FG upwards with a 45° bank angle, then flies on a constant circular path at V_0 and radius r until reaching horizontal flight with: $r = \frac{V_0^2}{g}\ [m]$ The height taken by contingency manoeuvre results approximately in:

		$$H_{CM} = 0.3\frac{V_0^2}{g}\ [m]$$ c) <u>Using of parachute when leaving FG</u> If flight is terminated by triggering a parachute directly when leaving the Flight Geography with a 45° bank angle: $$H_{CM} = V_0 \cdot t \cdot 0.7\ [m]$$ With t : time until parachute deployment [s]

13.3.3 Calculation of the ground risk buffer (GRB)

Note: The following adresses only initial ground risk buffer definitions (equivalent to JARUS SORA 2.0 M1 Criterion #1 at low robustness level). Any further considerations on higher level robustness for strategic ground risk mitigations (SORA step #3), including the definition of ground risk buffer, are not within the scope of this GM and subject to a detailed review from the competent authority.

The ground risk buffer being a surface, the following presents 4 methods to calculate its lateral extent (S_{GRB}) depending on the UAS configuration.

Method 1 **<u>Generic approach (1:1 rule)</u>** This method can be applied for all UAS configurations.	$$\boldsymbol{S_{GRB} = H_{CV} + \frac{1}{2} \cdot CD\ [m]}$$
Method 2 **<u>Ballistic approach</u>** Applicable to rotary wing UA only.	$$\boldsymbol{S_{GRB} = V_0\sqrt{\frac{2H_{CV}}{g}} + \frac{1}{2} \cdot CD\ [m]}$$ Note: the ballistic descent is the case where the aircraft has no lift, and only gravity and drag affects the UA. However, a simplified ballstic approach is considered here, with point in space approach (no drag taken into account).
Method 3 **<u>Flight termination with parachute</u>**	$$\boldsymbol{S_{GRB} = V_0 \cdot t + V_{wind}\frac{H_{CV}}{V_z}\ [m]}$$ • t : elapsed time until parachute deployment [s] • V_Z : rate of descent with parachute deployed [m/s] • V_{wind} : maximum allowable wind speed for operation [m/s] *Note: values of V_{wind} smaller than 3 m/s are considered unrealistic*
Method 4 **<u>Flight termination of fixed-wing UA</u>**	**a)** <u>Engines are stopped and the UA glides</u> $$\boldsymbol{S_{GRB} = \frac{H_{CV}}{\epsilon}\ [m]}$$ With Glide ratio $\epsilon = \frac{C_L}{C_D}$ **b)** <u>Engines are stopped and the rudder position is permanently selected so that glide is no longer possible</u> Generic approach (method 1 – 1:1 rule) applies:

	$$S_{GRB} = H_{CV} + \frac{1}{2} CD \, [m]$$ Alternatively, further substantiation based on flight dynamics assessment or demonstration (tests) may be conducted.

13.3.4 Creation of all necessary volumes in KML format

After determination of the flight geography, contingency volume and ground risk buffer, the coordinates of the outer boundaries of these volumes and/or projected areas have to be provided to the FOCA in a readable format. In the case of flight geography and contingency volume, it should consist in the outer boundaries of these volumes projected on the ground. The resulting coordinate points should then be connected in sequence with straight lines.

13.3.5 Process and software tools

In order to ease the processing of applications, it is recommended to define FG, CV, GRB areas and coordinates with general purpose mapping softwares and export this data in a *.kml/.kmz file.

In case of a location-specific ('precise') operation, this file needs to be attached to the application form (Part 1) for an operational authorization. The coordinates stored in the *.*kml* file are therefore part of the operational authorization.

For location-independent ('generic') operation, examples of scenario as well as specific flight planning procedures and limitations are expected as part of the ConOps Documentation/Operator's Manuals. Clear operational limitations and dilligent flight planning procedures are expected to ensure any flight will meet the target level of safety, in any operation.

Several free and public mapping software tools can be used to create *.kml files, including:

- Maps of Switzerland - Swiss Confederation - map.admin.ch
- Google Earth Pro Desktop - Earth Versions – Google Earth
- Google Earth Browser - earth.google.com;
- Dipul, tool provided by the German National Authority to build operational volumes - maptool-dipul.dfs.de
- QGIS - qgis.org
- GpsPrune - Activity Workshop - GpsPrune

Depending on the software, it is also possible to define a height for the generated surfaces. This allows to generate 3D volumes for the definition of Flight Geography and Contingency Volumes. If the maximum height of Flight Geography and Contingency Volume is constant for the intended operation, it is not necessary to provide 3D coordinates. However, the height of Flight Geography and Contingency Volume must be clearly specified in the Operations Manual.

13.3.6 Denomination of elements

The following elements should be included in the *.*kml* file, with strict denomination shown in bold:

- **Flight Geography** - as a polygon in green;
- **Contingency Volume** - as a polygon in yellow;
- **Ground Risk Buffer** - as a polygon in red;
- **Crew position**– Position of remote pilot (and possible observers) as a **black marker**;
- **TO/LD** - Take-off and landing position of the UAS as blue marker.

Note:
Please make sure that the values calculated for the CV and GRB are actually maintained within the drawn coordinates submitted in the *.*kml* file. Exact positioning of coordinates and lines can be difficult when drawing polygons manually with a mapping software. It is therefore highly

recommended to apply a conservative approach (i.e. use of buffers) when drawing CV and GRB in order to avoid submitting lower values than those calculated and require.

Further guidance on the use of Maps of Switzerland is given on help.geo.admin.ch.

13.4 Practical examples

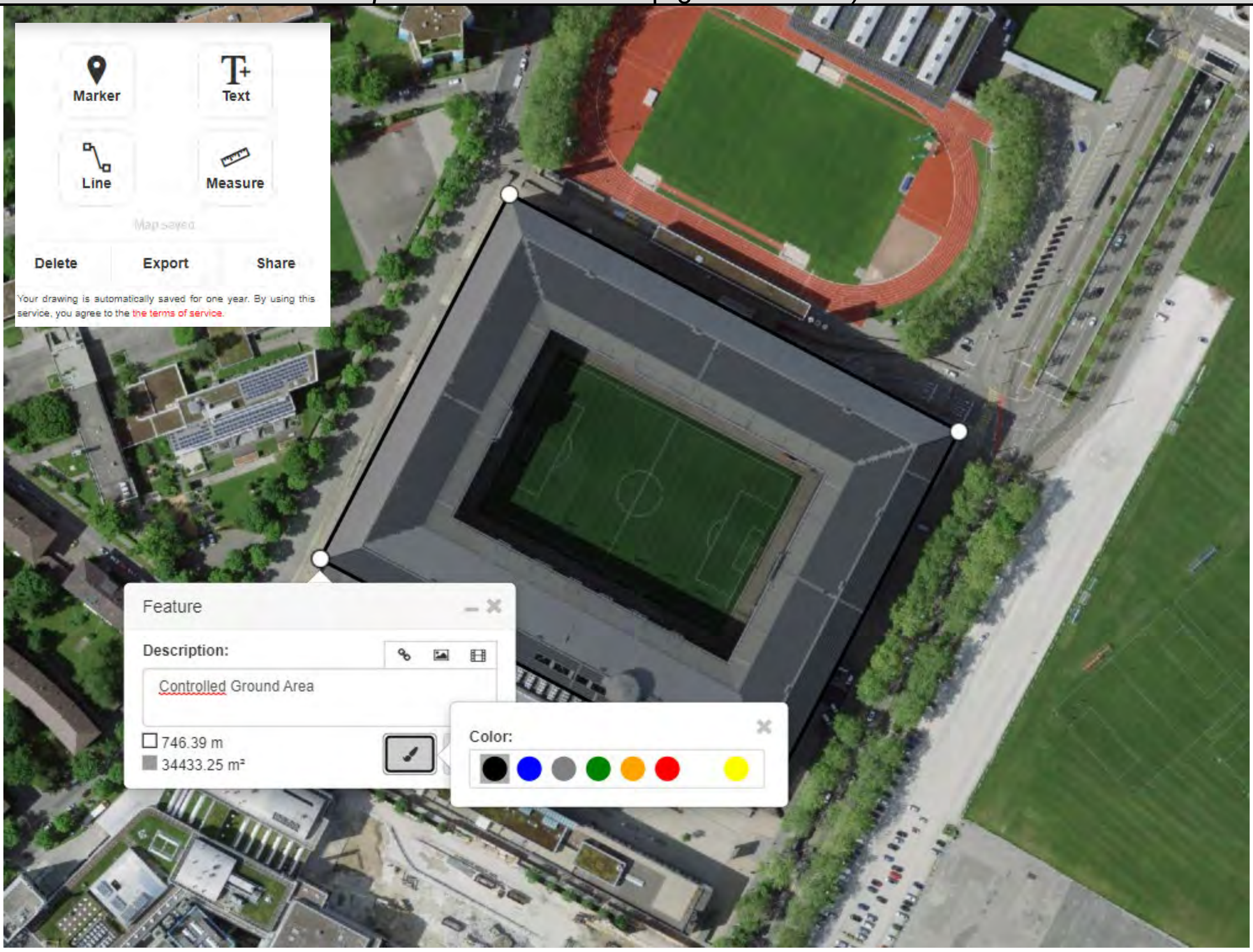
13.4.1 Example 1: OUT-IN planning (controlled ground area) using www.map.geoadmin.ch

In this example, operations are conducted within a controlled ground area. In this context, the FG, CV, and GRB must be completely contained with the controlled ground area. Therefore, it is recommended to start determining the volumes from the outer edge of the GRB to the FG (from outside to inside). For the sake of the example, we consider the following assumptions and initial parameters:

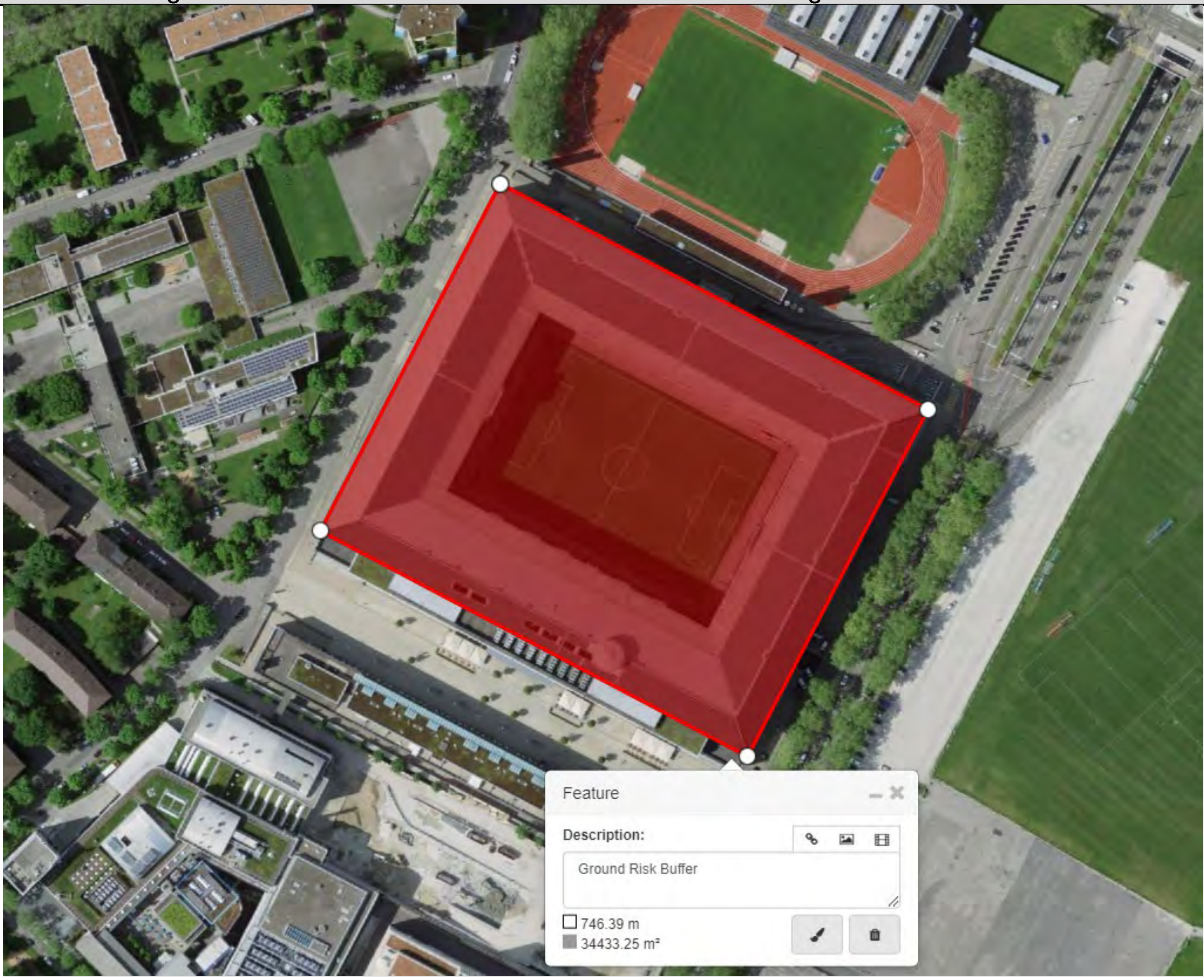
Parameter	Value
Type UA	Multicopter
V_0	10 m/s
CD	1.5 m
H_{baro}	1 m (error barometric measurement)
H_{FG}	80 m (AGL)

Step #1: From Controlled ground area to initial Ground Risk Buffer

A) Start by plotting the controlled ground area on the map (here as a black line drawn with the "*Draw & Measure on map / Line*" tool from map.geo.admin.ch):



B)	Since the outer boundary of the Ground Risk Buffer corresponds to the controlled ground area, the initial ground risk buffer area is identical to the controlled ground area.



Step #2: Calculation of Ground Risk Buffer to determine Contingency Volume
By calculating the dimension of the ground risk buffer, the contingency volume can be determined and its projection drawn on the map. Since a rotary wing UA is used in this example, the ballistic methodology approach is used with the initial parameters to calculate the size of the GRB.

Ballistic approach:

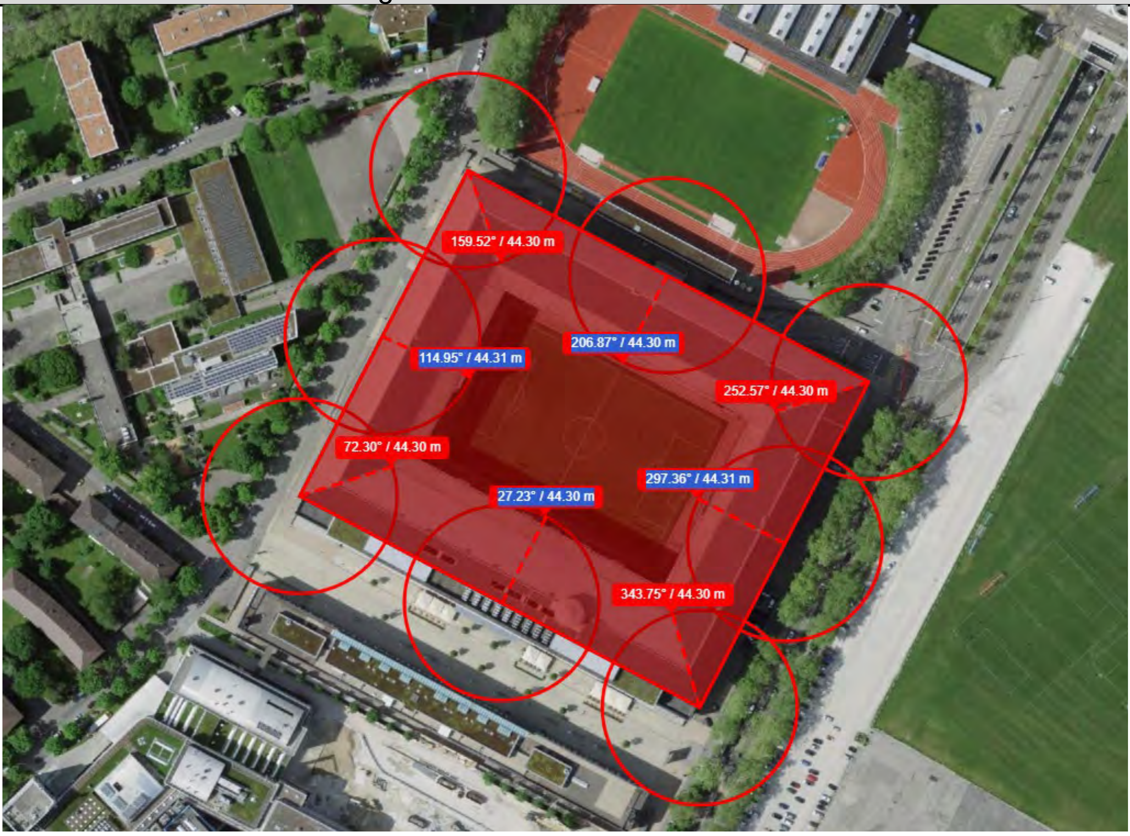
$$S_{GRB} = V_0 \sqrt{\frac{2H_{CV}}{g}} + \frac{1}{2} CD \; [m]$$

With $H_{CV} = H_{FG} + H_{baro} + H_{RT} + H_{CM} = 93.1\,m$

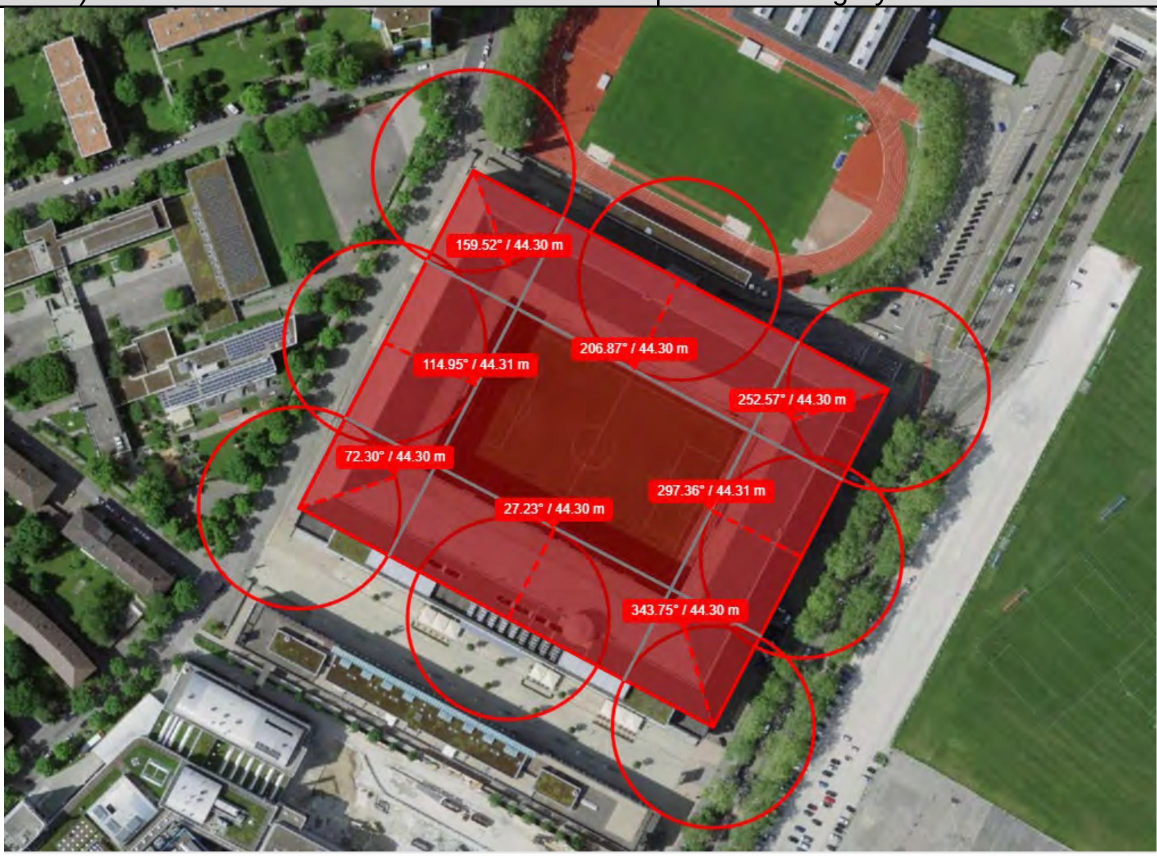
$$S_{GRB} = 10m \sqrt{\frac{2 \cdot 93.1m}{g}} + \frac{1}{2} \cdot 1.5\,m = 44.3\,m$$

To draw the contingency volume based on GRB size, use “*Draw & Measure on map / Measure & Line*” tools from map.geo.admin.ch.

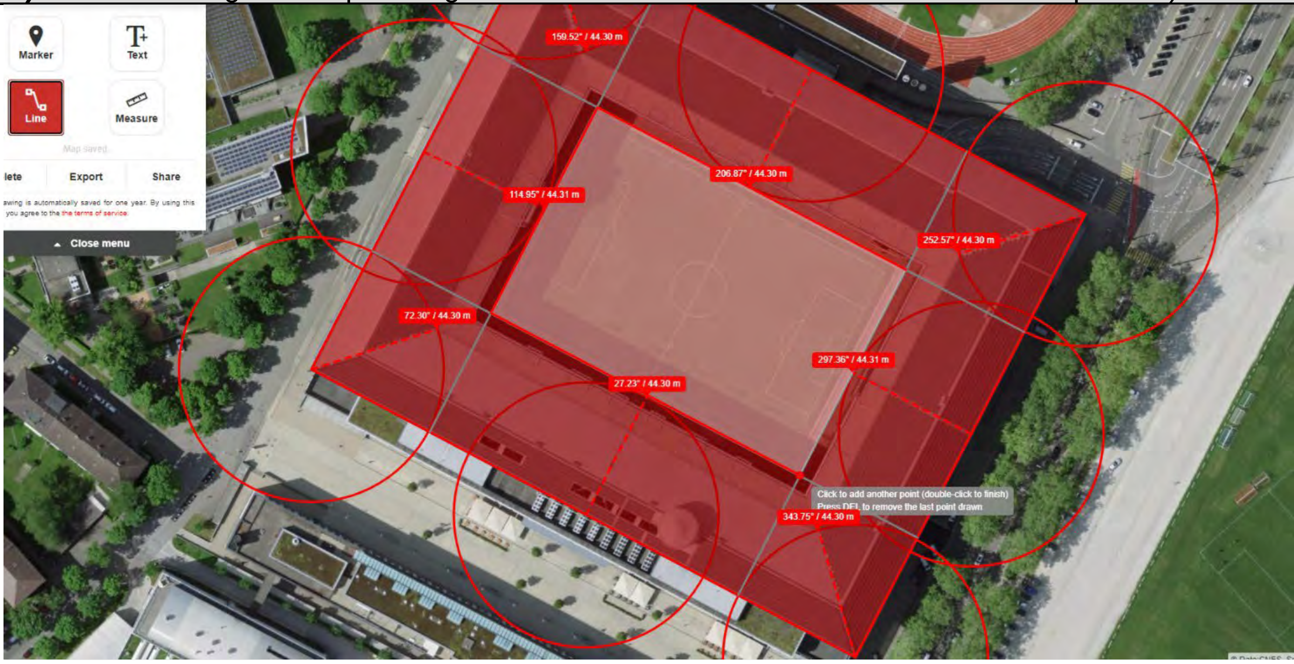
A) In this example, the width of the GRB is measured from the outside to the inside at each edge and side of the GRB/controlled ground area.



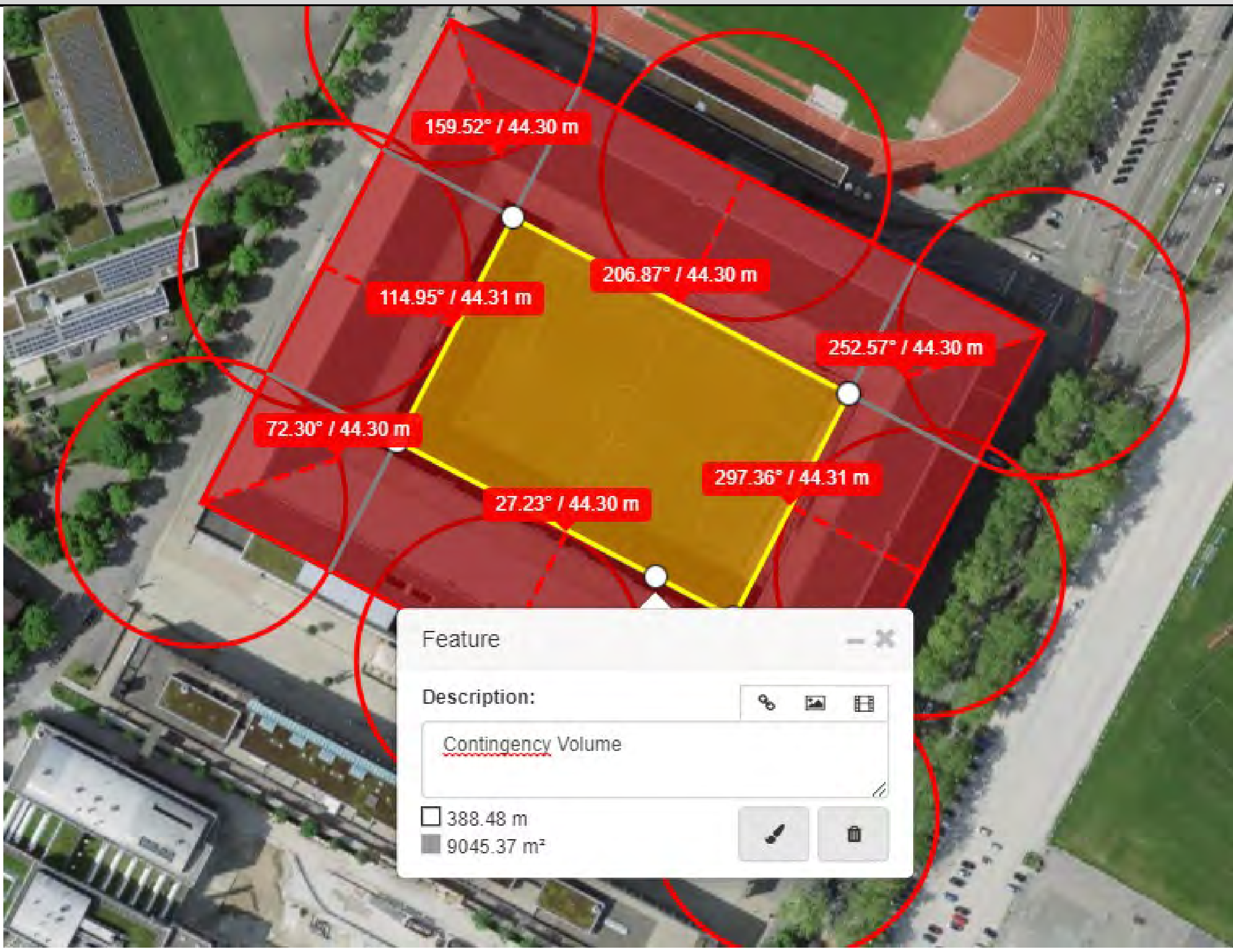
B) Point A) above allows to draw construction lines represented in gray below.



C) Draw a rectangular shape using the "Line" tool and the contruction lines from point D).



D) Name the feature "*Contingency Volume*" and use the yellow color code.



E) Measures and construction lines can be deleted to prepare the next step.

Tip: Click precisely on the dotted line to delete measure.

Step #3: Calculation Contingency Volume to determine Flight Geography

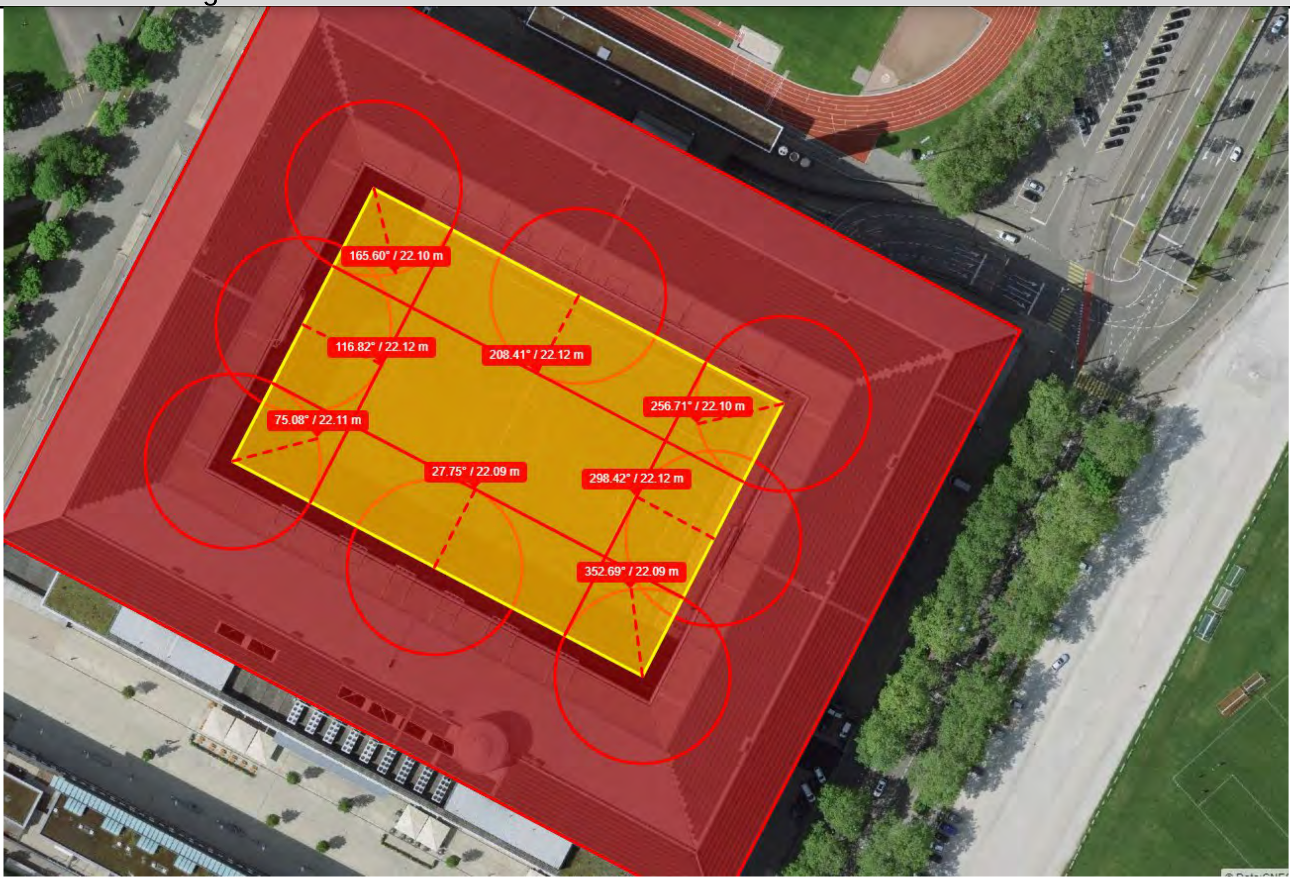
Similar to the process delineated above to determine the Contingency Volume from the size of GRB, the Flight Geography results from subtracting the lateral size of the Contingency Volume to the remaining area.

Calculation of CV Lateral (cf. §13.3.2):

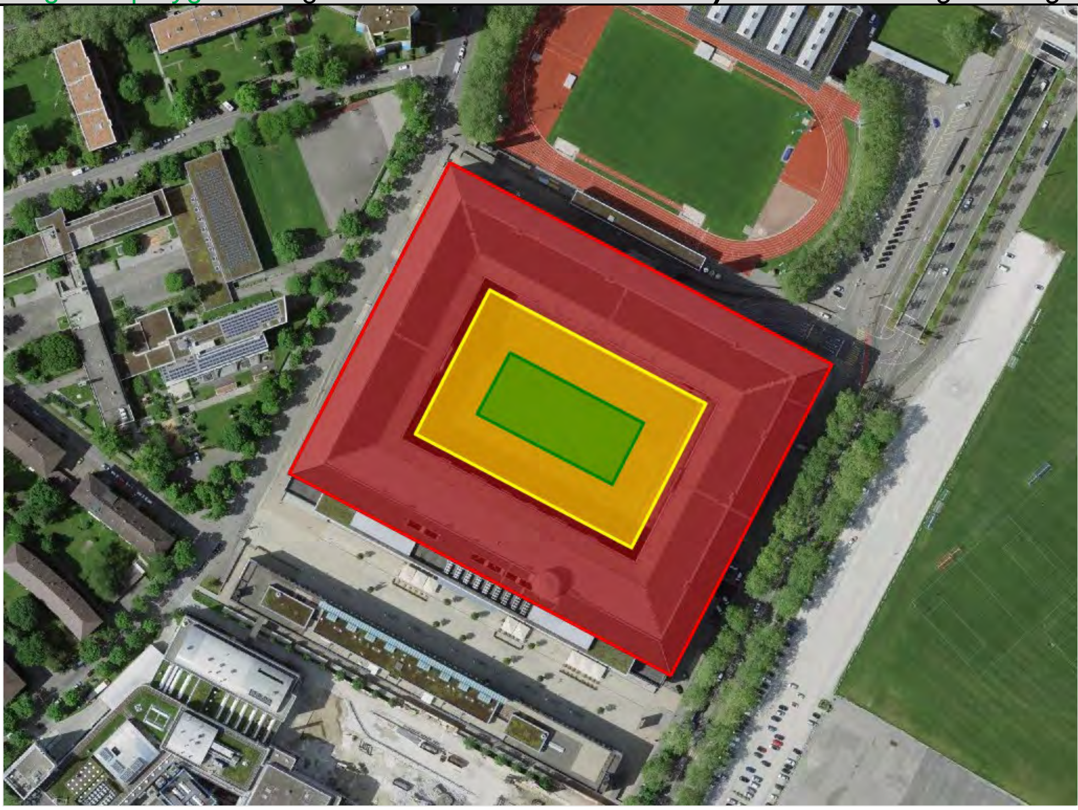
$$S_{CV} = S_{GPS} + S_{POS} + S_{MAP} + S_{RT} + S_{CM}$$

$$S_{CV} = 3m + 3m + 1m + 10\,\frac{m}{s} \cdot 1s + \frac{1}{2} \cdot \frac{\left(10\frac{m}{s}\right)^2}{9.81\,\frac{m}{s^2}\tan(45°)} = 22.1\,m$$

A) Similarly to the above, the width of the contingency volume is measured from the outside to the inside at each edge and side of the projected area. Construction lines can be drawn to define the resulting surface.



B) Draw a green polygon using the construction lines from **A)** and name it "*Flight Geography*".



C) The height of the contingency volume is determined using guidance provided in §13.3.2.

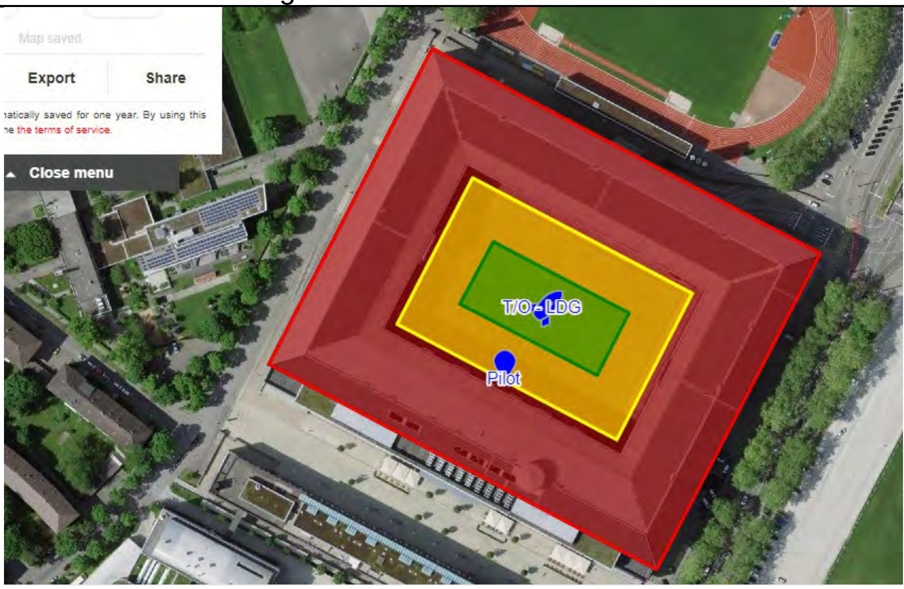
$$H_{CV} = H_{FG} + H_{baro} + H_{RT} + H_{CM}$$

$$H_{CV} = H_{FG} + H_{baro} + V_0 \cdot 0.7 \cdot 1s + \frac{1}{2}\frac{V_0^2}{g}$$

$$H_{CV} = 80m + 1m + 7m + 5.1m = 93.1\,m$$

Export as KML

The location of the pilot and of the take-off and landing points can be added on the map with the "Marker" feature. The *.kml file (including the layer "Drawing") can then be exported by clicking on the "Export" button from the drawing menu.



13.4.2 Example 2: IN-OUT Planning (flight route over a lake) using Google Earth Pro

The following example explains how to manually create a **.kml* file using Google Earth Pro.

In this example, operations are conducted along a short flight route over an agricultural field. The size of the Flight Geography results from the length and width of the route itself. For the sake of the example, we consider the following assumptions:

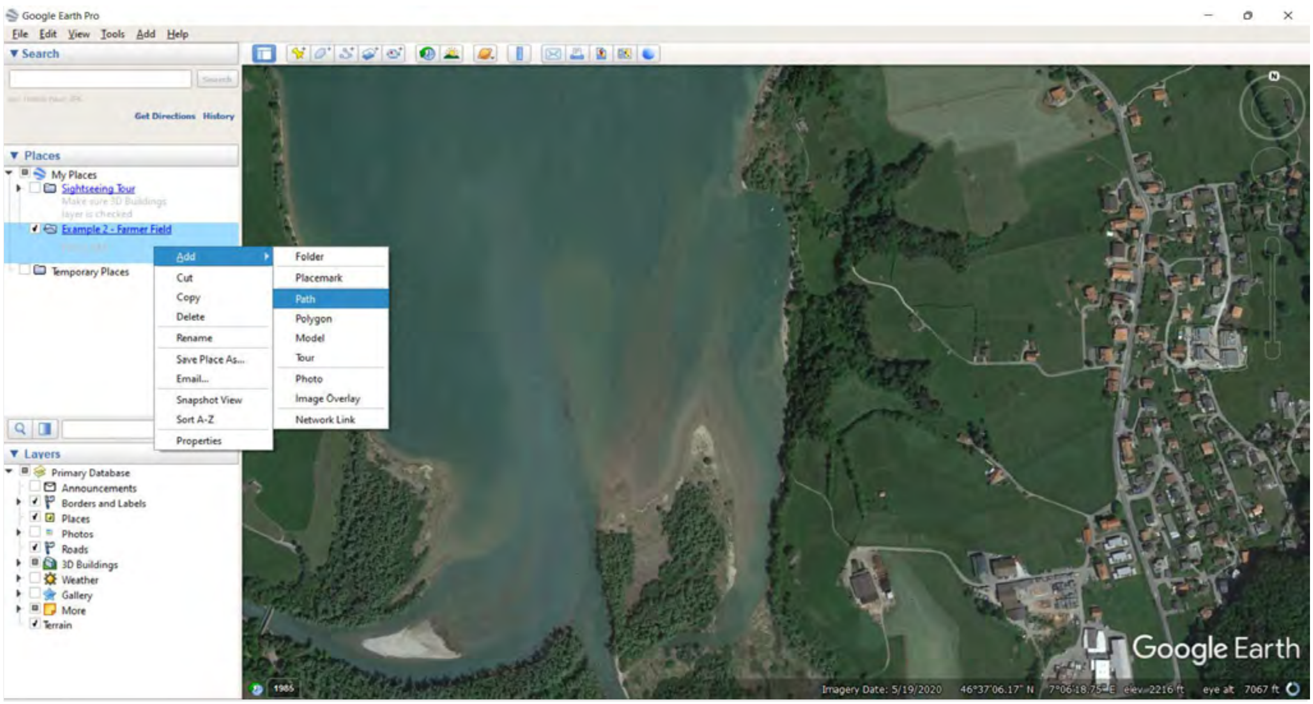
Parameter	Value
Type UA	Fixed-wing
V_0	30 m/s
CD	3 m
H_{baro}	H_{baro}= $1m$ for barometric measurement
H_{FG}	100 m

STEP #1 – Draw the flight geography (FG)

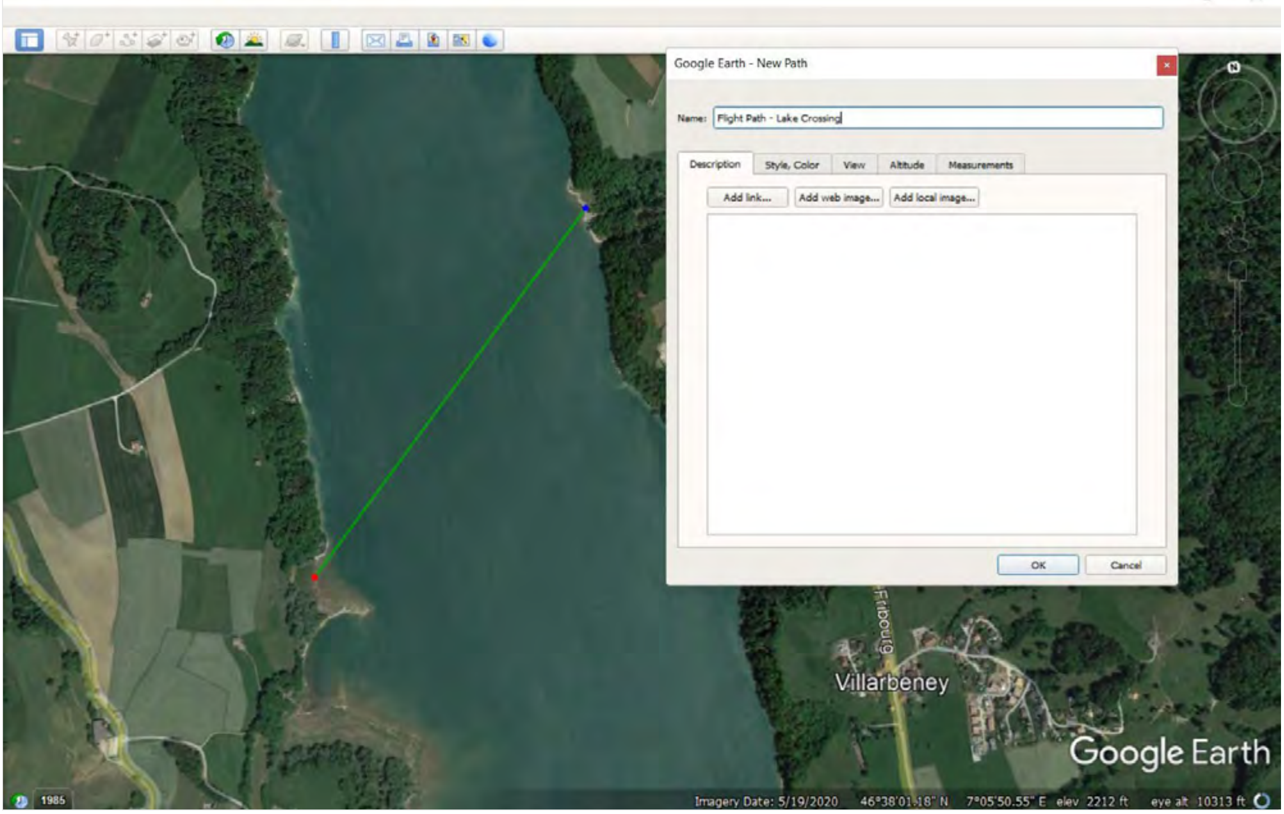
The FG has been defined as follows:

- Width Flight Geography: $W_{FG} \geq 3 \times CD = 9$ m ➔ **W_{FG} of 10 m is based on UA characteristic**
- Height Flight Geography: $H_{FG} \geq 3 \times CD = 9$ m ➔ **H_{FG} selected is 100m**

A) Create a new project and add a “Path”

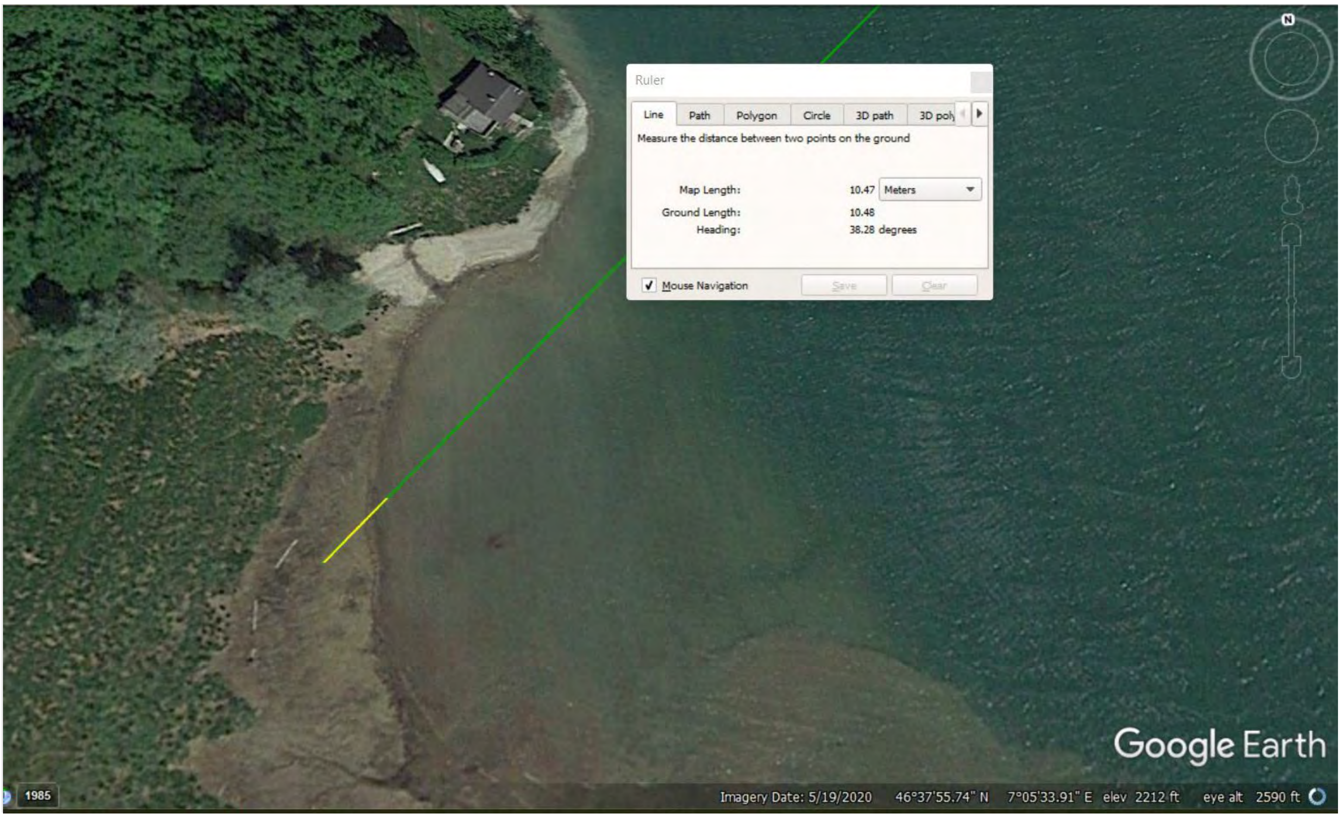


B) Draw the flight path – waypoints

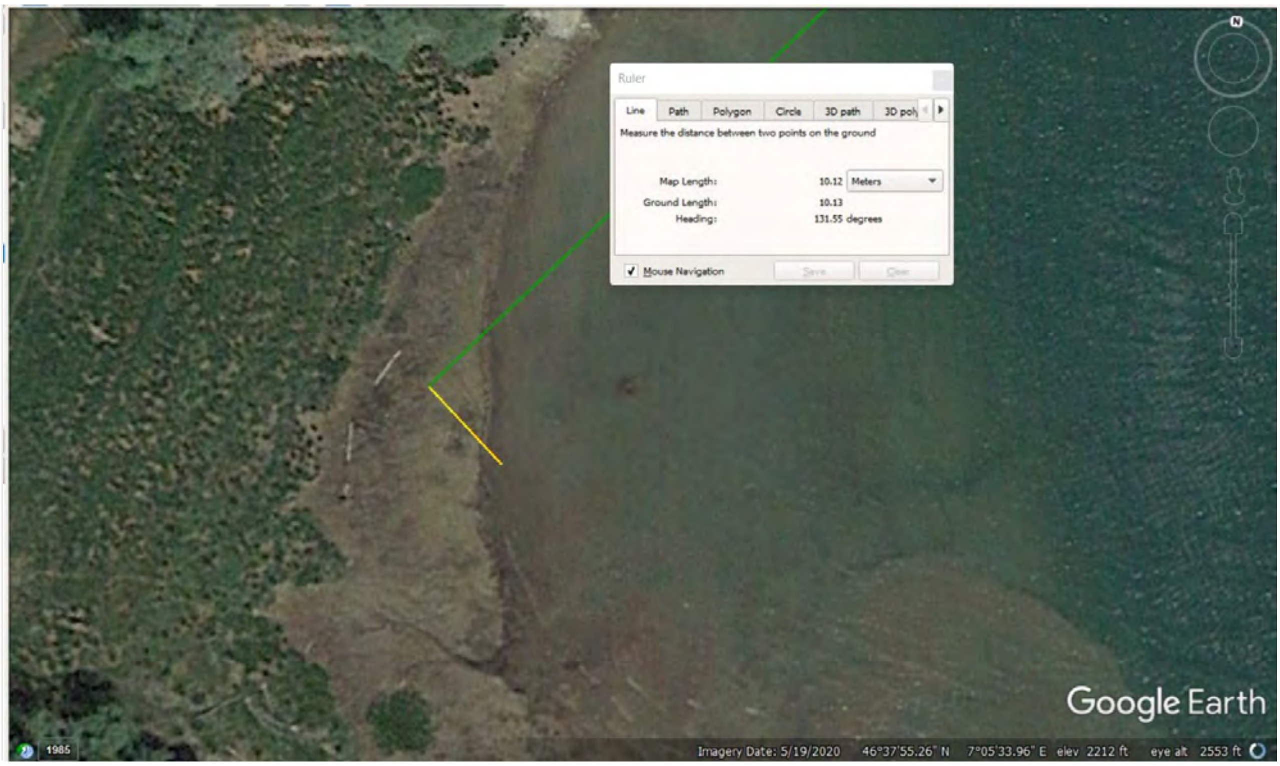


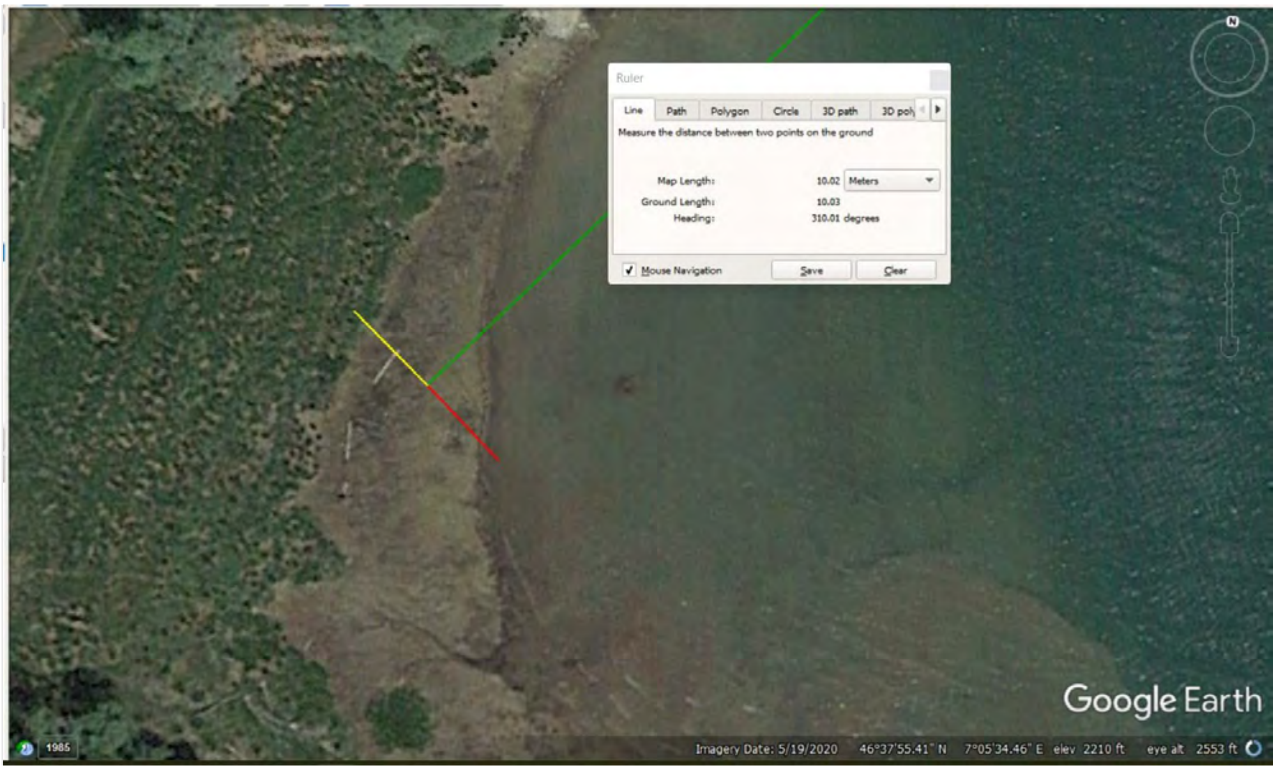
C) Measure the distance from the flight path to draw Flight Geography

Use "Ruler/Line" tool to determine heading of flight path.



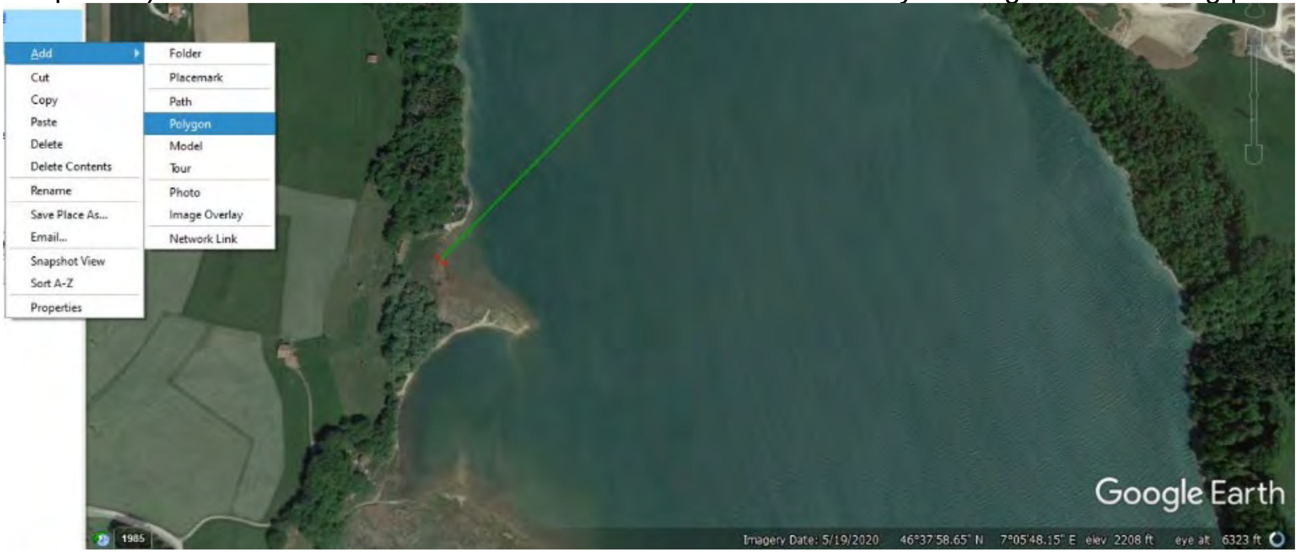
Distance to flight path must be measured at +/- 90° from this heading.


Ruler
Line Path Polygon Circle 3D path 3D poly
Measure the distance between two points on the ground
Map Length: 10.12 Meters
Ground Length: 10.13
Heading: 131.55 degrees
Mouse Navigation
Save Clear
Google Earth
1985
Imagery Date: 5/19/2020 46°37'55.26" N 7°05'33.96" E elev 2212 ft eye alt 2553 ft

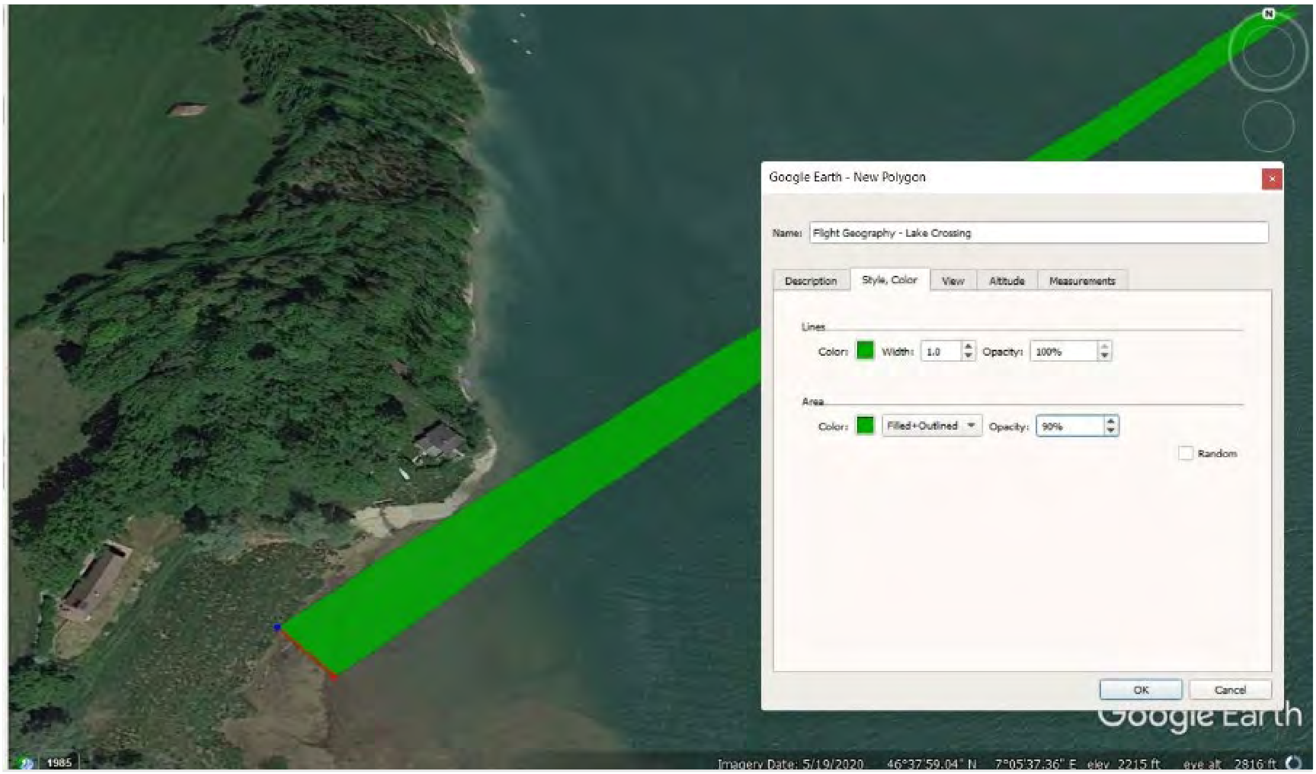

Ruler
Line Path Polygon Circle 3D path 3D poly
Measure the distance between two points on the ground
Map Length: 10.02 Meters
Ground Length: 10.03
Heading: 310.01 degrees
Mouse Navigation
Save Clear
Google Earth
1985
Imagery Date: 5/19/2020 46°37'55.41" N 7°05'34.46" E elev 2210 ft eye alt 2553 ft

D) Draw a polygon as flight geography

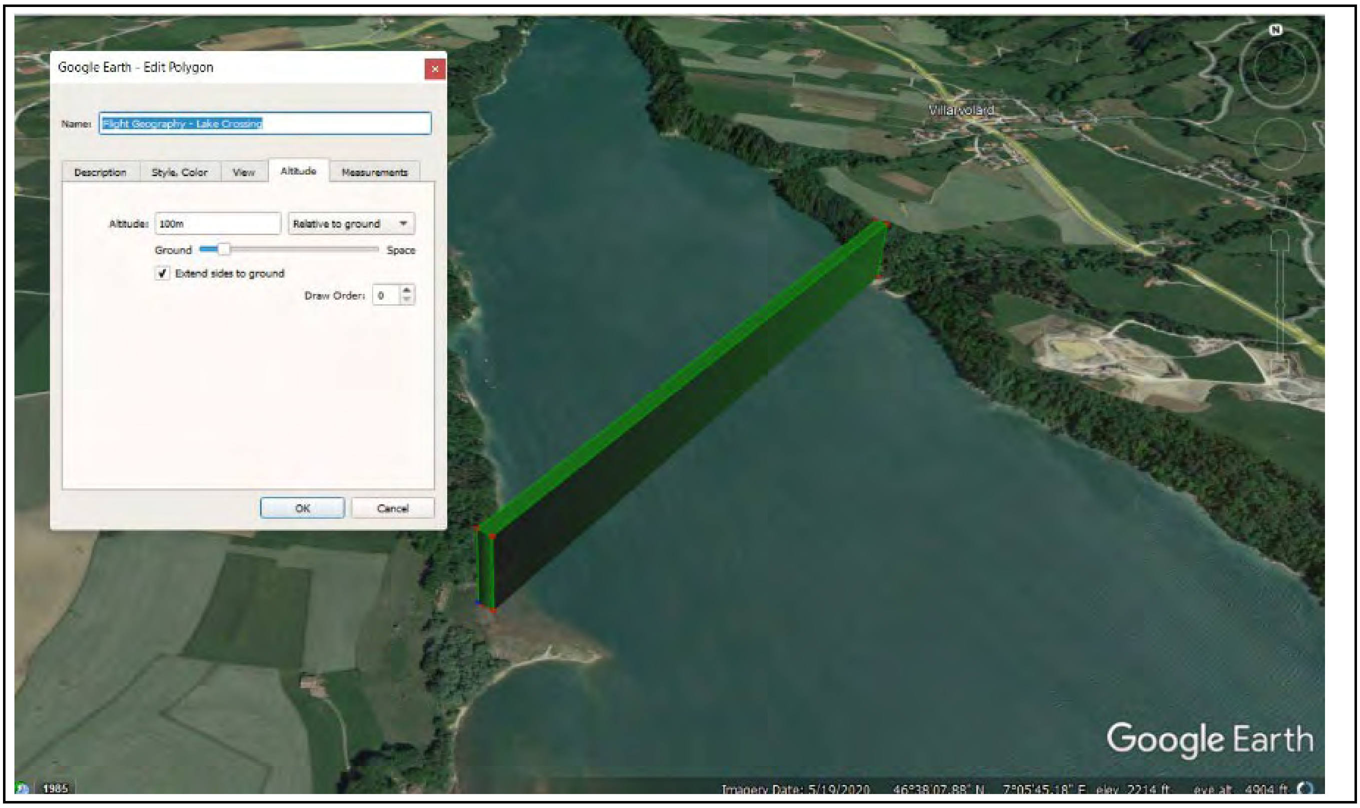
Use the “Add” > “Polygon” function: lines are drawn as the outer contour of the flight geography, whereby a corner point is created by clicking. The coordinates of these corner points (small circles in the picture) are later saved in the *.kml file. The contour is closed by clicking on the starting point.



Give the shape a name and a colour. After closing the form, it is given a name. The nomenclature should be unique and correspond to §13.3.6.



(optional) **Add Altitude**: The generated Flight Geography can be shaped in 3D by adding an altitude relative to ground using the tab “Altitude” and the option “Extend to the ground”.


Google Earth - Edit Polygon
Name: Flight Geography - Lake Crossing
Description
Style, Color
View
Altitude
Measurements
Altitude: 100m
Relative to ground
Ground
Space
Extend sides to ground
Draw Order: 0
OK
Cancel
Villarvolard
Google Earth
1985
Imagery Date: 5/19/2020 46°38'07.88" N 7°05'45.18" E elev 2214 ft eye alt 4904 ft

STEP #2: Calculate and draw the contingency volume (CV)

Reminder: In this example, the UA is fixed-wing; refer to §13.3.2 for the calculations guidance.

Calculation of the lateral extent of the CV (S_{CV}):

$$S_{CV} = S_{GPS} + S_{POS} + S_{MAP} + S_{RT} + S_{CM} \text{ ,}$$

with $S_{CM} = \frac{V_0^2}{g\ \tan(\phi)}$ **(U-Turn Curve with** $\phi_{max} \leq\ 30°$**)**

$$S_{CV} = S_{GPS} + S_{POS} + S_{MAP} + V_0\ t_{RT} + \frac{V_0^2}{g\tan(\theta)}$$

$$S_{CV} = 3m + 3m + 1m + 30m + 158.98m = 195.9m$$

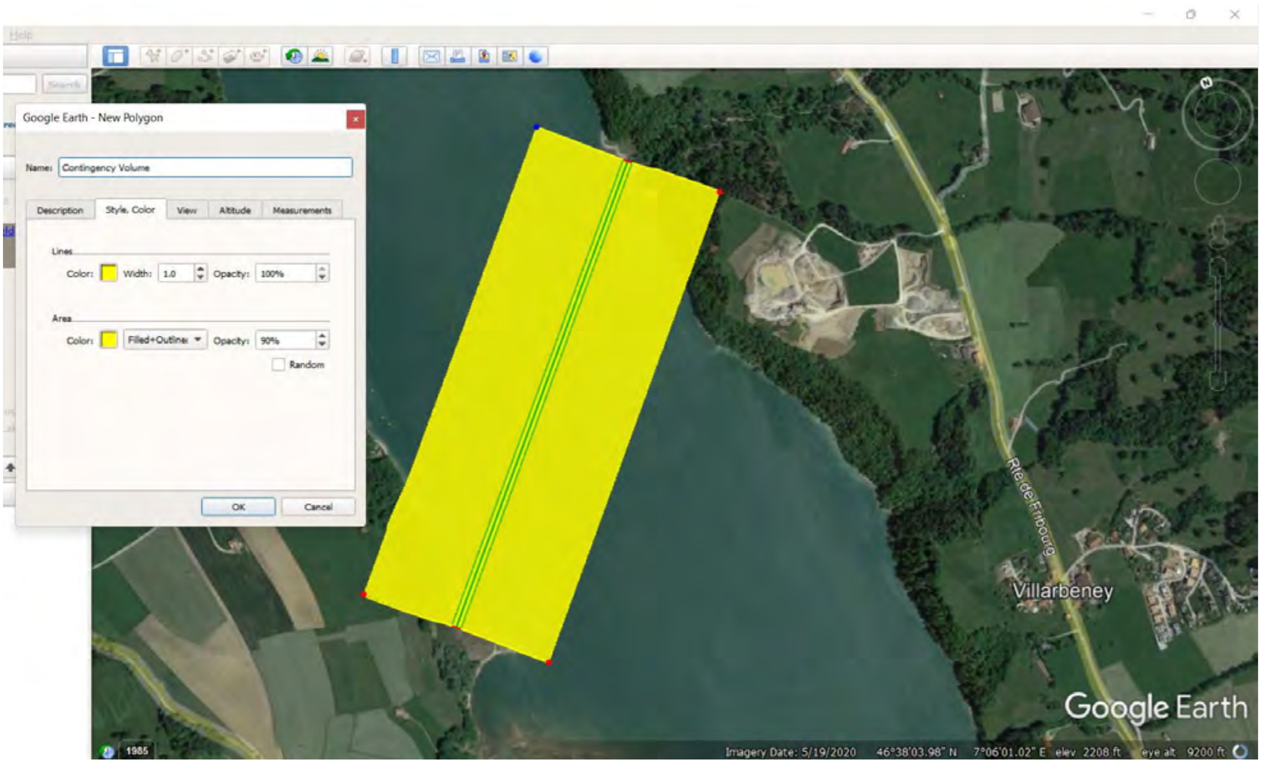
Calculation of the vertical extent of the CV (H_{CV}):

$$H_{CV} = H_{FG} + H_{Baro} + H_{RT} + H_{CM},\ H_{CV} = H_{FG} + H_{Baro} + V_0 \cdot 0.7 \cdot 1s + 0.3\frac{V_0^2}{g}$$

$$H_{CV} = 100\,m\ +\ 1\,m\ +\ 7m\ + 3.06\,m\ =\ 111.06\,m$$

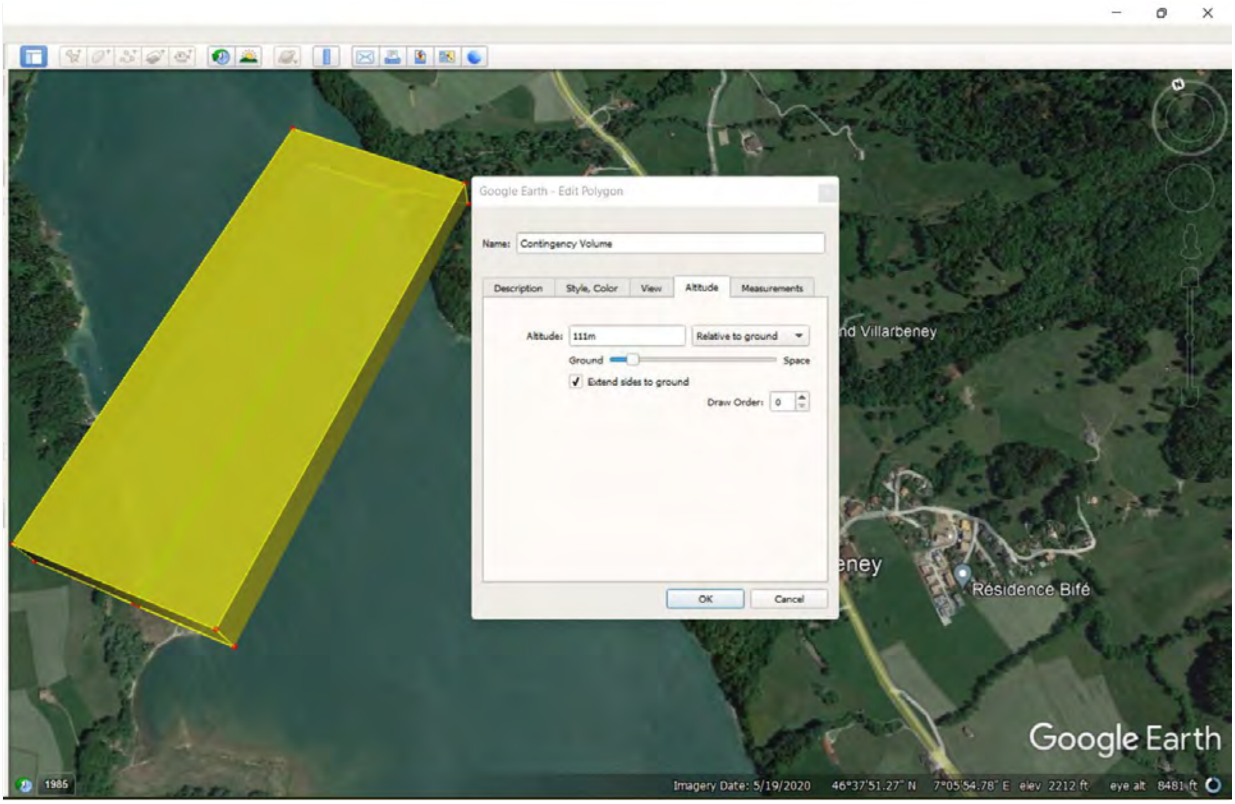
A) Add Polygons

As for the first exemple (§13.4.1), add Polygons to draw the outer contour of the contingency volume with the dimensions calculated above.

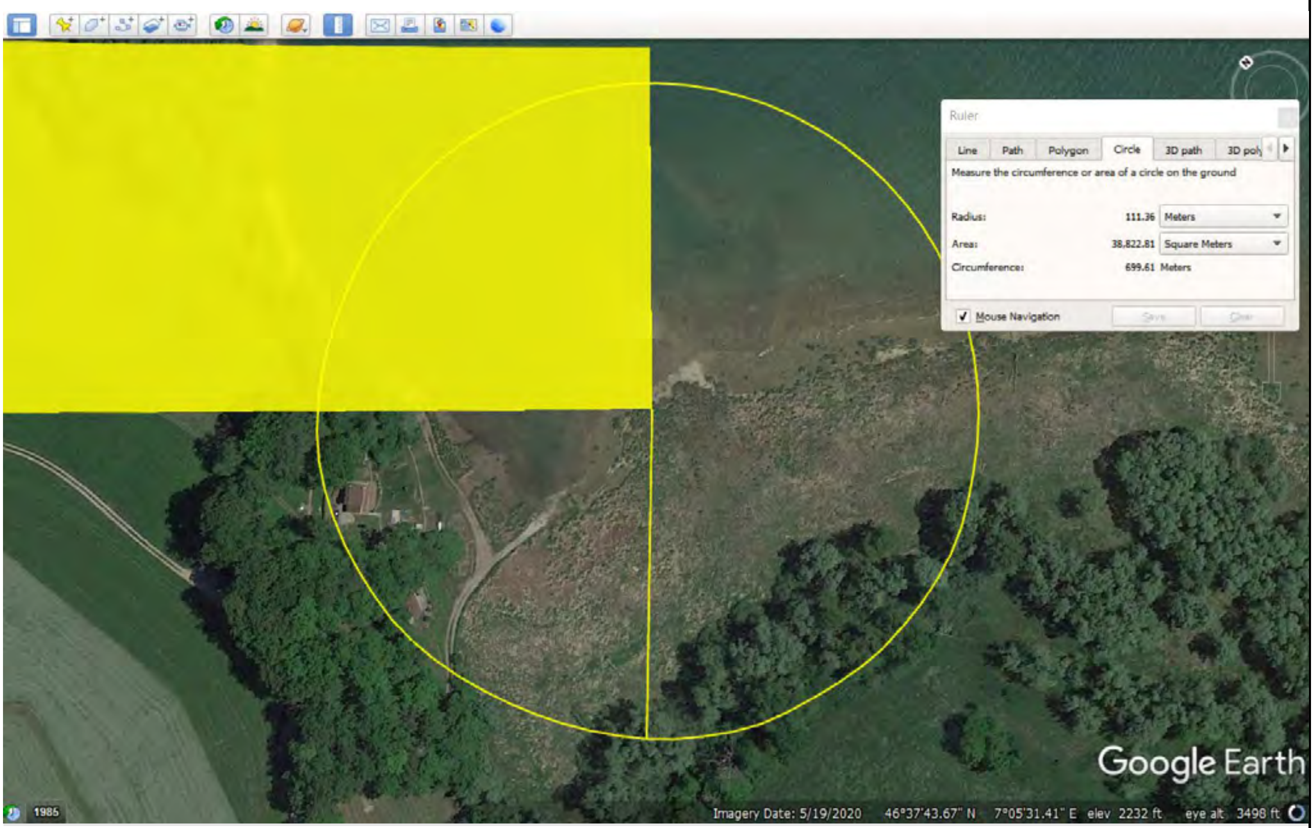


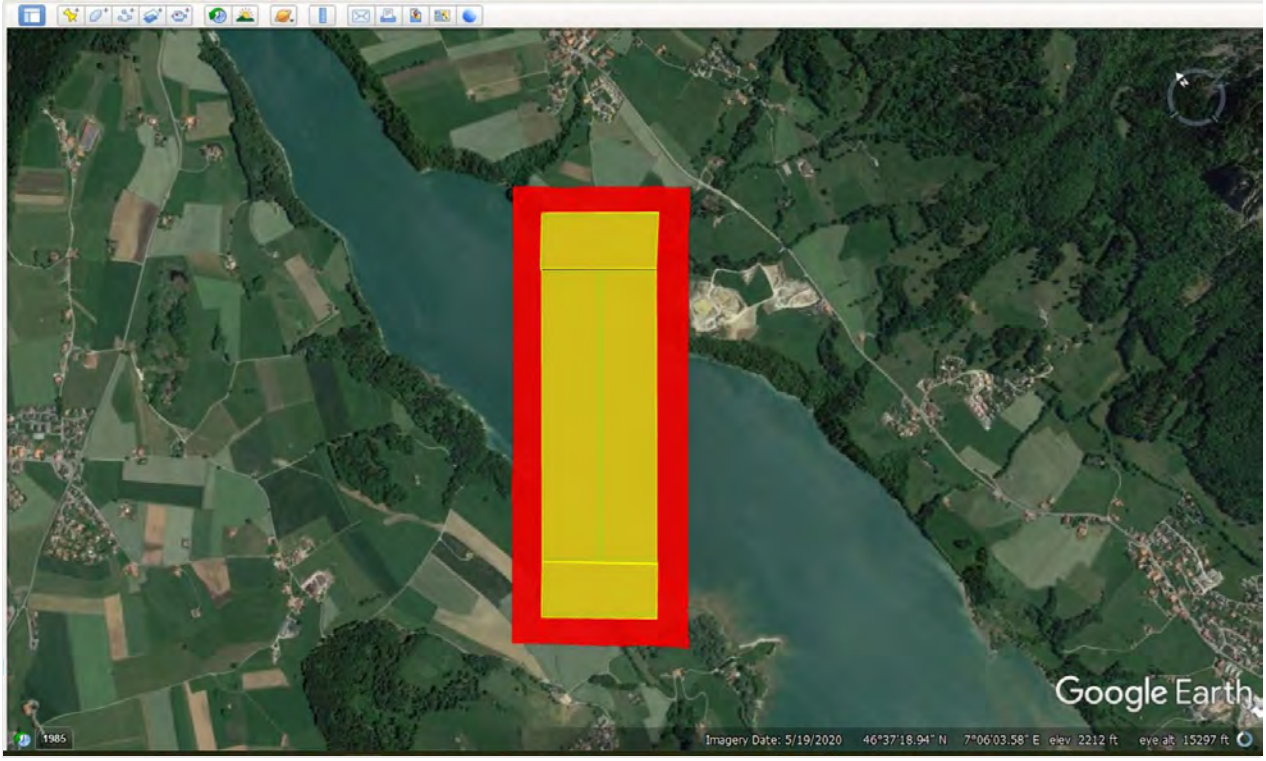
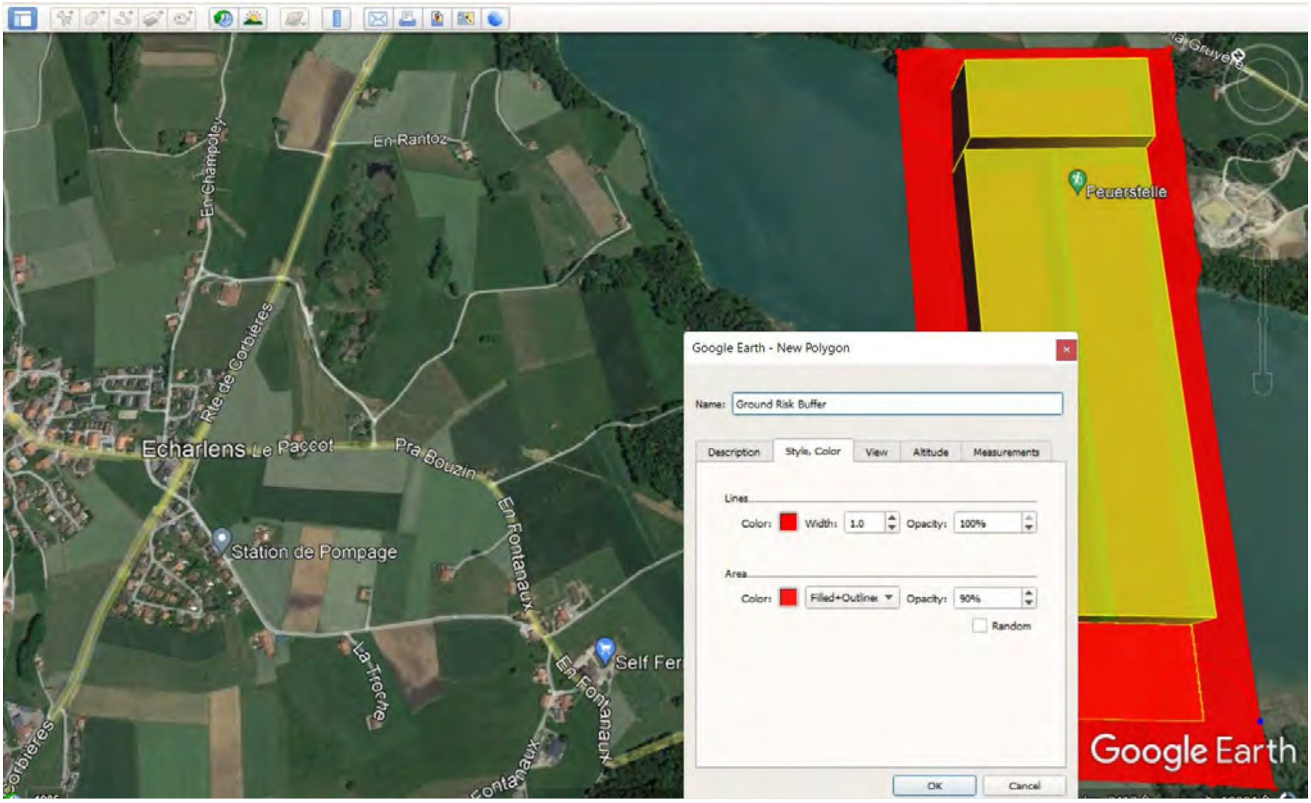
B) Create volume

Add Altitude: The generated Contingency Volume can be shaped in 3D by adding an altitude relative to ground using the tab “Altitude” and the option “Extend to the ground”.



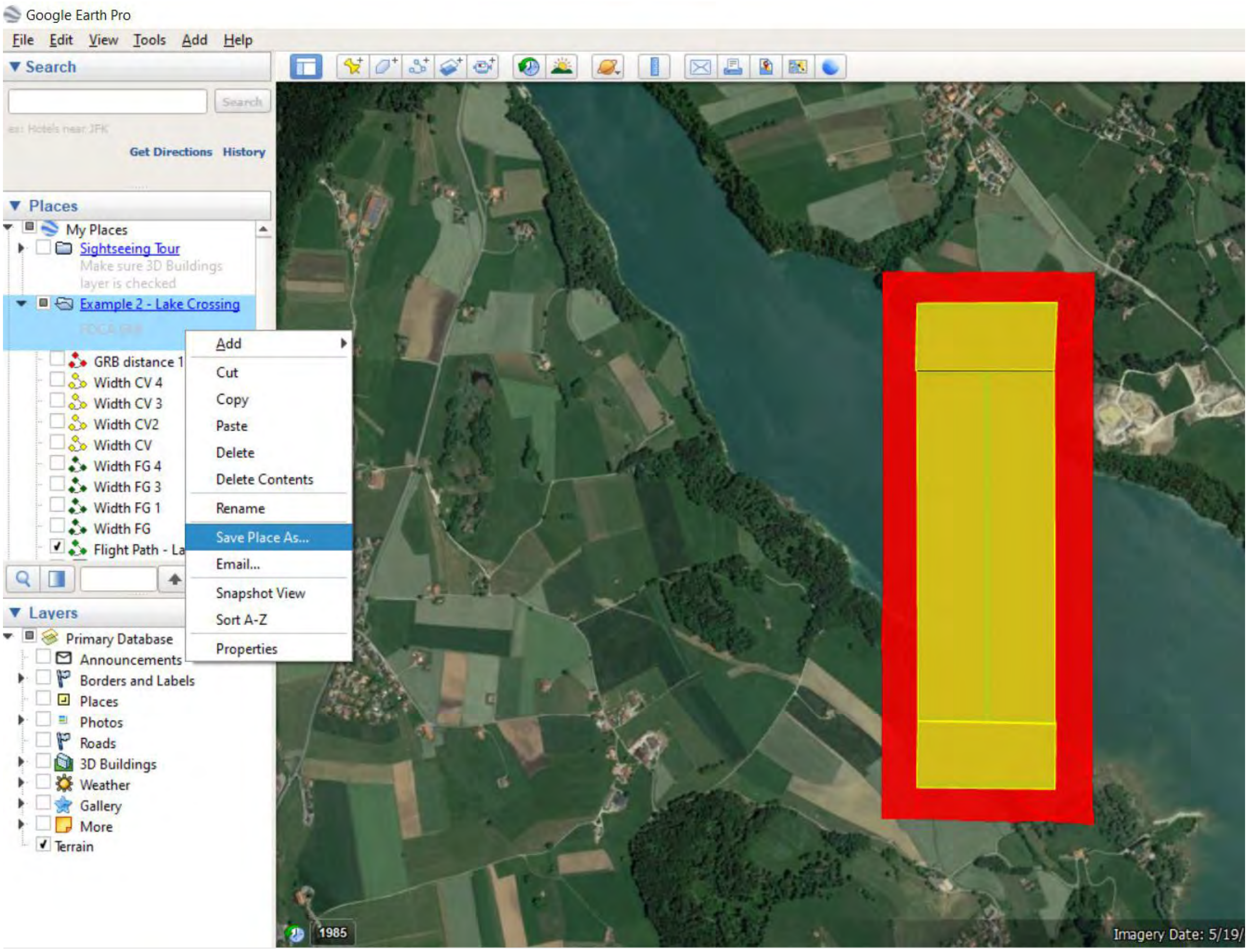
STEP #2 – Calculate and draw the ground risk buffer
Calculation of S_{GRB} using the "Method 1 – 1:1 rule" (cf. §13.3.2 for the calculations guidance: $$S_{GRB} = H_{CV} + \frac{1}{2}CD = 111.09m + \frac{1}{2} \cdot 3m = 112.41m$$
A) Measure distance of GRB



B) Add polygon/surface

As for example 1, add Polygons to draw the outer contour of the GRB with the dimension calculated above.
C) Name the GRB


STEP #3 – Export in KML

- Go to "File" > "Save" > "Save Place As"
- In the new window, go to the left-hand panel and select a folder
- In the "File name" field, type the name of the file
- Click on "Save"
- Google Earth will save the file as a *.kmz* file, which includes the KML file.



Please refer to Google Official Support page for further help: [Google Earth Help](#).

14 Additional guidance on Air risk

14.1 Aeronautical fundamentals

The objective of this section is to explain some aeronautical concepts which can be relevant for UAS operators when planning a specific operation.

14.2 Airspace Classification

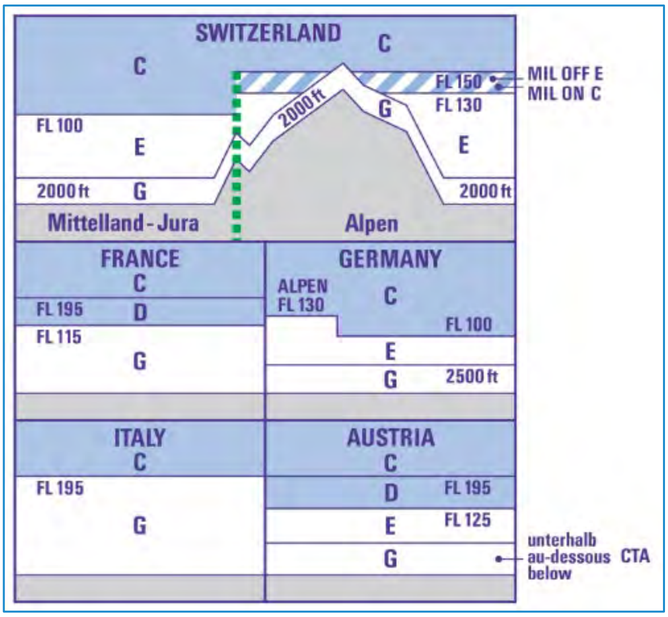
The world's navigable airspace is divided into three-dimensional segments, each of which is assigned to a specific class. Most nations adhere to the classification specified by the International Civil Aviation Organization (ICAO), although they might use only some of the classes defined below and significantly alter the exact rules and requirements. Similarly, individual nations may also designate special use airspace (SUA) with further rules for reasons of national security or safety.

Switzerland consists of a single FIR (Flight Information Region) which is divided into the areas of responsibility of Zurich and Geneva. On the ICAO chart, this dividing line runs from the Chasseral over the Bernese Highlands to Fiesch and is marked “CTA Zurich” and “CTA Geneva”. This line is only of importance for pilots who wish to obtain a permit or information from the Air Traffic Control centers DELTA or FIC via radio. Within the FIR, the airspace is divided into four ICAO classes: **C, D, E and G**. Each of these airspace classes has different conditions of use, which apply uniformly to all airspace users. These are regulations concerning entry clearance and separation between users but also regulations concerning flight visibility and distance from clouds. Within the FIR, the airspace contains additional structure like the division into Control Zones (CTR), Terminal Control Areas (TMA) and Airways (AWY), as well as Radio Mandatory Zones (RMZ). These airspaces are assigned to a class according to their traffic volume. For example, the TMAs in Zurich and Geneva belong to airspace class C, while most other civilian and military TMAs and CTRs belong to airspace class D. A distinction is also made between controlled and uncontrolled airspace. Class C, D and E are controlled, Class G is uncontrolled airspace.

Uncontrolled airspace G covers the terrain in a height band from the ground to 600 m (2’000 ft) above ground over the entire territory of Switzerland - except for control zones (CTRs), which extend to the ground, and TMAs with low-set lower limits.

To find the airspace class of a specific location, different aeronautical charts can be used. The most useful being the official ICAO chart which can be found here: [Aeronautical Chart ICAO.]

The symbol definitions of the ICAO chart can be found here: [Symbology.]



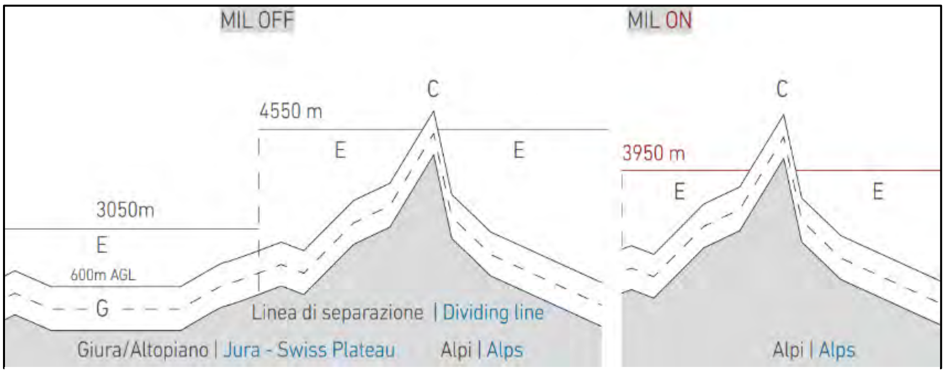


Figure 15: Airspace Classes, MIL ON/OFF

14.3 Altitude Format

Altitude is the vertical distance of an object measured from mean sea level. The primary unit of measurement of altitude and elevation or height is the meter. However, the most widely used unit of measurement in aviation is the foot/feet. Metric altitudes and flight levels are used in certain countries. ICAO Annex 5 and Supplement give a partial listing of the units of measurement used in most countries. If any doubt exists, the Aeronautical Information Publication (AIP) should be consulted.

1 m = 3.281 ft

1 ft = 0.3048 m

QNH: The pressure set on the subscale of the altimeter so that the instrument indicates its height above sea level. The altimeter will read runway elevation when the aircraft is on the runway.

Flight Level (FL): A surface of constant atmosphere pressure, which is related to a specific pressure datum (1013hPa) and is separated from other such surfaces by specific pressure intervals. In other words, a flight level depicts an altitude above sea level in 100 feet units measured according to a standard atmosphere.

Example: FL250 = 25’000 feet above mean sea level when the pressure at sea level is 1013.25 hPa.

Elevation or Height: The vertical distance of a level, a point, or an object considered as a point, measured from a specified datum. Most often used in combination with **AGL** = Above Ground Level.

14.4 Restrictions

On the ICAO chart, many red areas can be found. These show different types of airspace restrictions. (ICAO Annex 2: Rules of the Air)

Danger Area: LSD, an airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Restricted Area: LSR, an airspace of defined dimensions above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with specific conditions.

Prohibited Area: LSP, an airspace of defined dimensions, above the land area or territorial waters of a state, within which the flight of aircraft is prohibited.

Some restrictions may be only temporary or specific to certain dates or events, for example the protection of a conference. They can be found in the Daily Airspace Bulletin Switzerland (DABS) here: DABS (CH) - skybriefing. The DABS needs to be checked daily for any flight activity (dangers, restrictions and changes of airspace within Swiss territory) taking place in Switzerland, which includes unmanned aircraft operations.

14.5 Other definitions

Transponder:

A transponder is a receiver/transmitter, which will generate a reply signal upon proper interrogation; the interrogation and reply being on different frequencies. Used for positioning but can also transmit other data like altitude, depending on its mode.

Caution: The term “transponder” (abbrev. XPDR) typically means an actual Mode-A/C/S Transponder. Not all conspicuity devices are transponders, rather transceivers (such as commercially available products like FLARM). A Transponder is only 'detectable' based on the generation of a reply signal upon proper interrogation with SSR (Secondary Surveillance Radar) or a Traffic Collision Avoidance System (TCAS). Note that traffic information from aircraft equipped with Mode-S can be received via TIS-B/ADS-R rebroadcast services, which are not available in Switzerland, however mostly in the USA. Note also that not all transponders are equipped with ADS-B out capability. ADS-B out is available on aircraft equipped with “Mode-S extended squitter technology” which is not mandated for general aviation/ light aircraft and still rarely used by this category on a voluntary basis.

ADS-B:

“ADS-B” stands for Automatic Dependent Surveillance – Broadcast and is a means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data (derived from on board systems such a GNSS), as appropriate, in a broadcast mode via a data link.

Source: ICAO Doc 4444 PANS-ATM, skybrary.aero, [online link] Available 16.06.2023

Mode-C Veil:

Not used in Switzerland. Mode C veil refers to a kind of airspace, which currently surrounds all primary Class B airports within the United States. The name refers to the mode of transponder operation, which is required within this airspace — that is, with very limited exceptions, all aircraft operating within this airspace must have an altitude-reporting Mode C transponder in operation.

TMZ:

Transponder Mandatory Zone means airspace of defined dimensions wherein the carriage and operation of transponder equipment is mandatory. All flights operating in airspace designated by the competent authority as a TMZ shall carry and operate Secondary Surveillance Radar (SSR) transponders capable of operating on Modes A and C or on Mode S, unless in compliance with alternative provisions prescribed for that particular airspace by the ANSP.

VFR:

Visual Flight Rules simply means that the aircraft is intended to operate in visual meteorological conditions (VMC; nice and clear weather). Clouds, heavy precipitation, low visibility, and otherwise adverse weather conditions should be avoided under VFR. Most general aviation and flight training occurs in visual meteorological conditions.

IFR:

Instrument Flight Rules implies that the flight may operate in instrument meteorological conditions (IMC, meaning cloudy or otherwise adverse weather conditions). However, many aircraft may operate under IFR while completing the entirety of the flight in VMC due to the efficiency provided by IFR flying as well as the safety of continuing to avoid bad weather.

More information on these definitions can be found here: SKYbrary Aviation Safety.

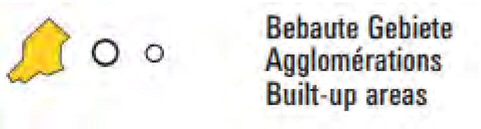
14.6 Additional Information

Population information:

Normal, manned VFR flights must maintain a minimum altitude of 1'000 ft over urban areas and 500 ft over rural areas (in accordance with regulation (EU) 923/2012, SERA.5005(f)). Special flights like the Swiss Air Force or Helicopter Emergency Medical Service (HEMS) Operations (e.g., Rega) may be encountered below these minima. However, the terms urban and rural are not clearly defined regarding these applicable minimum altitudes.

FOCA considers the use of the ICAO chart as adequate to check if the surface is an urban (yellow areas) or rural area:

- **Urban**: Urban is defined as the areas depicted in yellow, part of "built-up areas":

  In urban areas, an increased helicopter traffic at low level is expected.

  Examples of urban areas are: agglomeration surface of Zürich, Basel, Genève, Bern, Lausanne, Luzern, …

  Note: Highways (also depicted in light yellow on ICAO chart) are not considered as urban areas.

- **Rural**: For the purpose of this assessment, rural is defined as all non-urban areas and not within an airport environment.

Atypical airspace:

Atypical Airspace is defined as (JARUS SORA 2.0 Annex I):

- Restricted Airspace or Danger Areas;
- Airspace where normal manned aircraft cannot go (e.g. airspace within 30m/100ft of buildings or structures);
- Airspace characterization where the encounter rate of manned aircraft (encounter is defined as proximity of 3'000 ft horizontally and ± 350 ft vertically) can be shown to be less than 1E-6 per flight hour during the operation;
- Airspace not covered in Airspace Encounter Categories (AEC) 1 through 12;
- Outside of airport / heliport environment.

Airport / Heliport Environment:

FOCA's RPAS map should be used to identify, if an operation takes place in an airport / heliport environment. This is shown as magenta areas on the map.

In the SORA methodology, different distances depending on procedures and air traffic control services are prescribed to be an airport / heliport environment. This approach may also be used but the deviation from the RPAS map must be justified.

Similarly, some heliports, including hospital landing sites most commonly used by Rega and other HEMS operators (shown on map.geo.admin.ch), might not be considered as airport/heliport environment in the view of the SORA methodology, due to a low density of traffic.

14.7 Traffic considerations relevant for OPS in airspace G below 500ft AGL

As explained in the Airspace Classification section, operations of crewed aircraft in uncontrolled airspace class G below 500ft AGL over rural areas are not common, as well as operations of crewed aircraft below 1000ft AGL over urban areas. However, this does not imply that no traffic can be found at those altitudes. When considering the amount and type of crewed traffic that operates at those low altitudes, the following should be considered:

Helicopter Emergency Medical Services (HEMS)

HEMS operations (such as those performed by REGA) can take place at very low altitudes in any type of terrain. However, it is more likely to find this kind of traffic in mountainous areas and in the vicinity of hospitals and heliports. An overview of most hospital landing sites can be found on map.geo.admin.ch.

Search and Rescue (SAR)

SAR operations can take place at very low altitudes in any type of terrain. Such operations are likely to be performed by helicopters of the Swiss Air Force and HEMS Operators (e.g. Rega) and typically take place in mountain areas and rural environment.

Swiss Air Force (SAF)

Military operations conducted by SAF can include any type of aircraft (helicopter, airplane, fighter jet) at any altitude, although most of the traffic below 500 ft AGL are likely to be performed by helicopters. Such operations can take place anywhere in Switzerland, being more likely in the vicinity of military airports and air bases.

Helicopter Special Operations

Helicopter special operations, such as aerial work are common in Switzerland and operate at altitudes below 500ft AGL. Such operations can take place in urban and rural environments, like in the vicinity of construction areas and in mountainous areas performing forestry missions. Although it can take place in summer, forestry aerial work is typically performed in autumn, winter and spring.

Mountain landing sites

Mountain landing sites are landing sites outside of aerodromes - i.e. without infrastructure - and at an altitude of more than 1'100 meters. They are used for instruction and training, as well as for transporting people for tourism. Special attention should be given to these sites if you are operating in their vicinity during the mountain flight period (November to Mai). Mountain Landing Sites are shown here on map.geo.admin.ch

VFR Emergency Landing Training

Even in uncontrolled airspace, it is permitted for training purposes to fly below minimum altitudes (acc. Art. 28 VRV-L / SERA.5005f) with an instructor (emergency landing exercises of airplanes and helicopters)

Gliders and Paragliders

Gliders and paragliders are commonly found in good weather conditions and in spring and summer time in rural and mountainous areas. Note that gliders soaring flights can take place with a minimum flight altitude is 60 m above ground while a sufficient lateral safety distance from the slope must be maintained (Art. 28 VRV-L). Gliders may also land outside of aerodromes.

Applicants should check free information sources for paraglider start spots and landing sites and write procedures to a pre-flight checklist.

Example free information sources for paraglider spots:

- Burnair
- Paragliding map

Some websites also offer live traffic tracking. For BVLOS operations, UAS operators should detect other airspace users unless the operation is conducted in ARC-a risk class airspace. However, note that these tools depict a non-exhaustive picture of the traffic, as not all gliders and paragliders are equipped with the necessary equipment to become conspicuous as this is not a mandatory requirement.

Example free information sources for live tracker information:

- GliderTracker
- Burnair Cloud

14.8 Guidelines for identification of an ARC-b airspace

It is important to note that the SORA methodology does not assume that there is “no expected traffic below 500 ft AGL” or, more generally, in Class G airspace.

Instead, SORA qualitatively characterises traffic density below 500 ft in uncontrolled airspace as low (iARC-b). Consequently, an ARC-b classification indicates that the likelihood of encountering another manned aircraft is low, but not negligible.

FOCA applies a conservative interpretation of this qualitative assessment. In practice, various types of manned aviation activity must be expected below 500 ft AGL (e.g. HEMS, aerial work/SPO, NOLA, autorotation training, gliders, paragliders, etc.). For this reason, airspace below 500 ft AGL in rural uncontrolled areas is not automatically considered to meet the conditions of iARC-b.

To justify an ARC-b classification, the operator must demonstrate a low risk of encounter, as required by §2.4.4.2(d) of AMC1 to Article 11. This demonstration must be more detailed than the initial air risk flowchart provided in Figure 4 of AMC1 to Article 11.

Additional guidance to support this assessment can be found in Appendix V and Appendix VI of the *EASA Guidelines on operations in the open and specific category* [Online link, Issue 03 available 28.11.2025].

14.8.1 For VLOS / EVLOS (BVLOS with Airspace Observer(s)) operations

The operator must demonstrate that the crew can be positioned so that the UA always remains within VLOS of either the remote pilot or an airspace observer who can continuously scan the sky and communicate in real time with the remote pilot, providing timely information on any other manned or unmanned aircraft in the operational area. Under these conditions, the crew is considered capable of assessing surrounding air traffic and, as a result, reducing the encounter rate by applying this mitigation both before and during the operation.

14.8.2 For BVLOS operations

The operator must demonstrate, for each type of traffic (e.g. helicopters, paragliders, aeroplanes, etc.), that the traffic density around the operational volume is particularly low as a result of the applied strategic risk mitigation measures.

To this end, a detailed analysis shall be carried out in order to:

1. Identify each type of manned traffic likely to be encountered during the operation;
2. Define the corresponding mitigations that ensure a low risk of encounter;
3. Estimate the expected equipage level of e-conspicuity devices, including the types of technology used and the proportion of equipped traffic.

A summary of this analysis shall be submitted to FOCA in the form of a hazard identification (HAZID) matrix. A template is available on the FOCA website [FOCA-UAS-GM-AIRSPACE, Online link, available on 28.11.2025].

In general, this evidence must demonstrate either that the drone’s operational area is rarely used by manned aviation, e.g. by operating close to infrastructure or over forests, within restricted airspace (LSR), in rural areas, or outside locations typically used for off-field landings, or that an active procedure has been implemented to ensure the absence of manned aircraft in the area of operation.

Such procedures may include, among other examples: coordination with major helicopter operators; flights in controlled airspace in collaboration with air traffic control (ATC); operations within aerodrome traffic patterns following consultation with the aerodrome manager; or targeted information campaigns directed at paragliding communities.

14.8.3 Support and Ressources

For further references and guidance, please refer to:

– *EASA Guidelines on operations in the Open and Specific category* [Online Link, Issue 03 available 28.11.2025].

– Future Aviation Surveillance Services and Technologies in Switzerland (FASST-CH).

– DETEC Ordinance of 20 May 2015 on Traffic Regulations for Aircraft (VRV-L; SR 748.121.11).

– Off-Airport Landing Ordinance of 14 May 2014 (AuLaV; SR 748.132.3).

– FOCA Directive on the Establishment of prohibited areas, restricted areas and danger areas (available in German (LR I-004 D) and French (LR I-004 F).

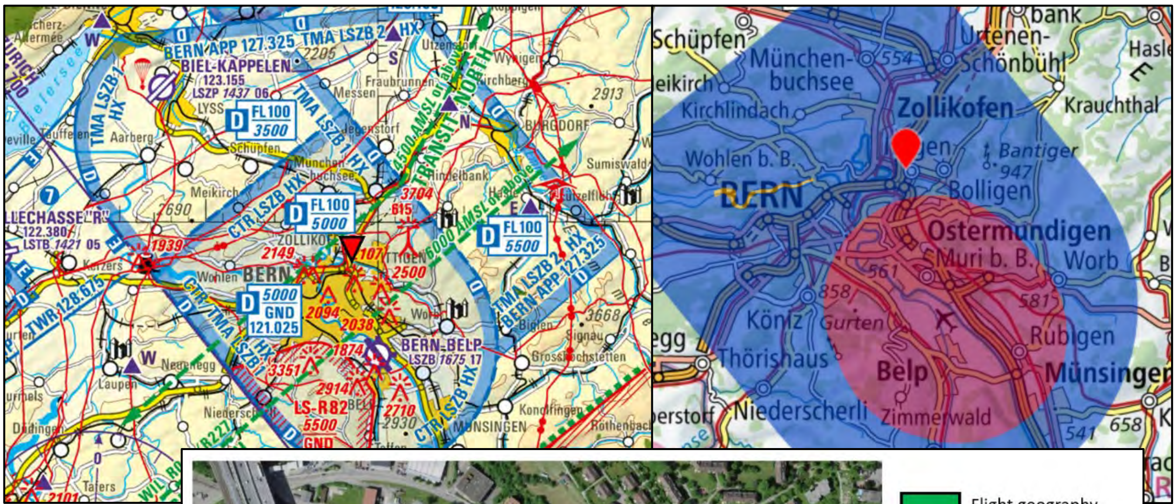
– Special Flights in C/D, Aeronautical Information Publication (AIP) (ENR 1.4, §2) and the Visual Flight Rules (VFR) Manual (VFR RAC 4-3, §12)

14.9 Example Cases

14.9.1 Example 1 – OPS < 500ft AGL in controlled airspace

In the second example, the flight takes place at the facilities of the Federal Office of Civil Aviation in Ittigen (BE) at a maximum altitude of 120m AGL (395ft).

As shown in Figure 9, by consulting the ICAO map, we can see that the operational flight location is within the CTR LSZB (airspace class D), considered as controlled airspace. The airspace class D (CTR LSZB) covers a volume from ground up to 5000 feet, and therefore our example operation (ground up to 395ft) is fully contained within it



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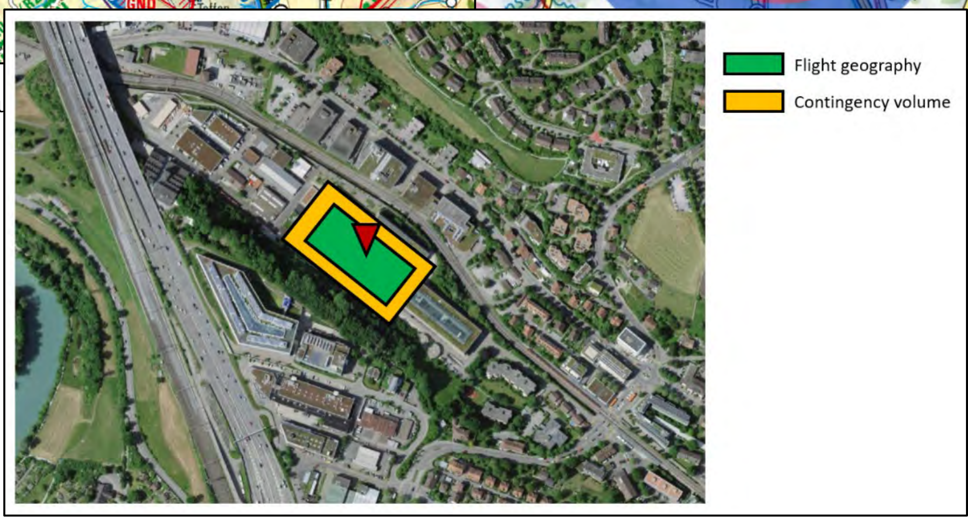

Figure 17 – Illustration of potential operational volume for example 2, Source: map.geo.admin

Following the flowchart in Figure 8, we can identify that as the operation takes place below 500ft AGL and in controlled airspace, the initial ARC (iARC) is therefore ARC-c.

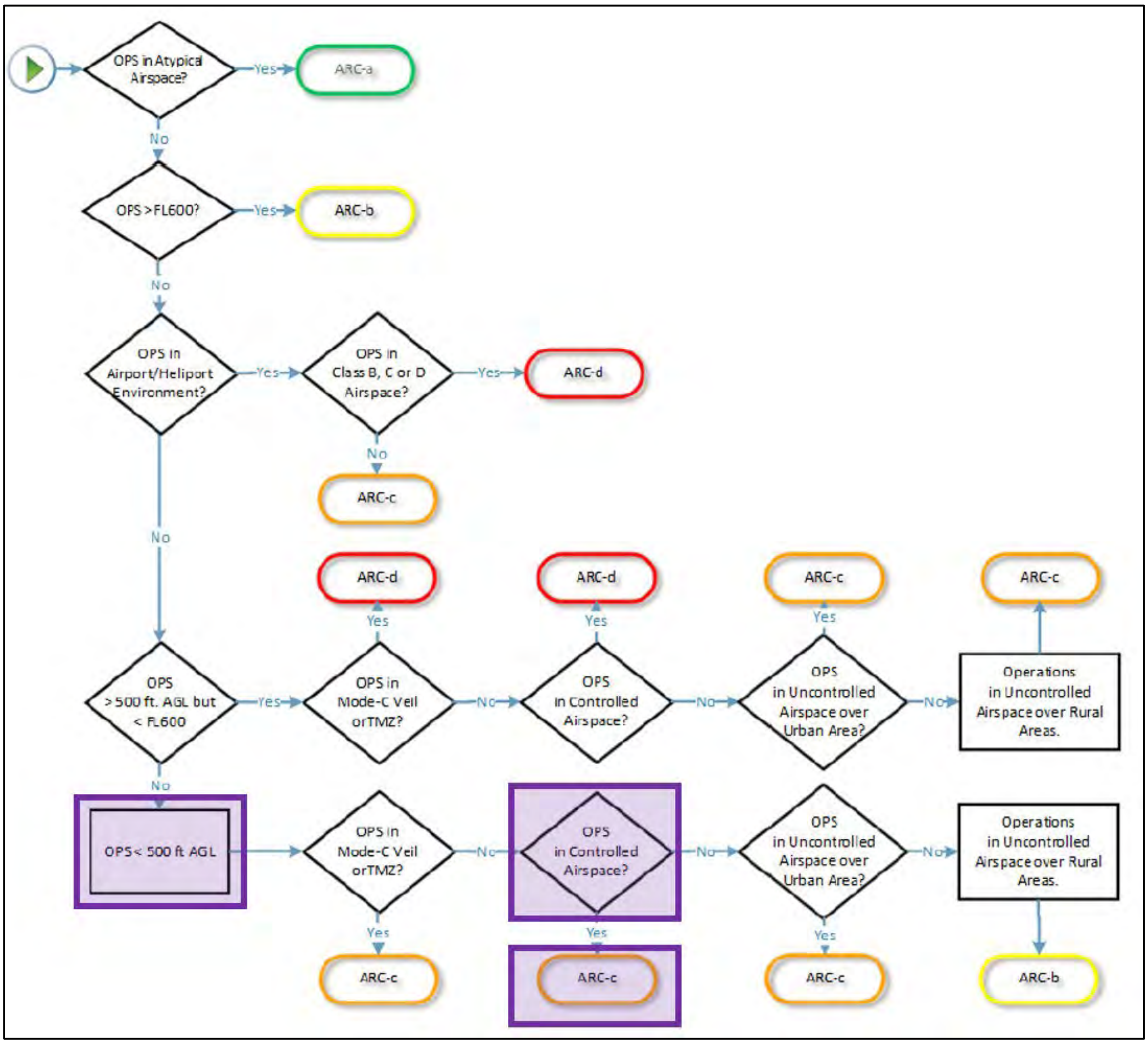

Figure 18 – ARC Flowchart for example 2, Source: JARUS guidelines

14.9.2 Example 2 – OPS in airport/heliport environment

In the third example, the flight takes place at Pully (VD) at a maximum altitude of 500m AGL (1640ft).

By consulting the RPAS map, we can see that the operational volume is situated within the no-fly zone (magenta) of the airport of Lausanne-La Blécherette.

According to the ICAO chart the location seems to be within the TMA LSGG (airspace class C), however TMA LSGG is defined from FL075 (ca. 7500ft AMSL) up to FL195 (ca. 19500ft AMSL), which is well above the upper limit of our operational volume (1640ft).

Note: Please be aware that operations in an airport/heliport environment additionally require the permission of the ATC unit concerned or the airport authority / manager according to the law. These requirements are also listed on the RPAS map when a certain area is selected.

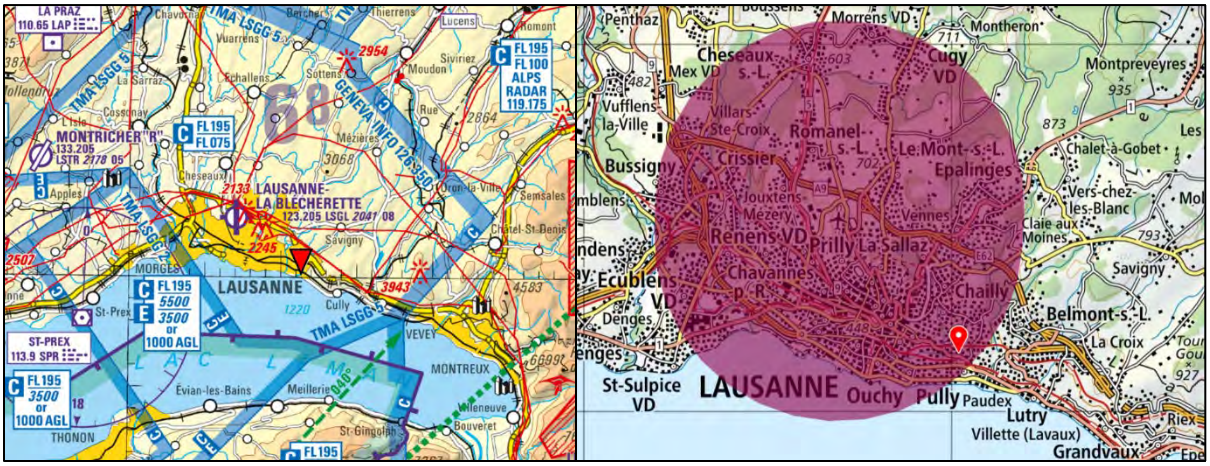

Figure 20 ICAO chart and RPAS restrictions map for example 3, Source: map.geo.admin

Figure 19 Illustration of potential operational volume for example 3, Source: map.geo.admin

Following the flowchart in Figure 8, we can identify that as the operation takes place in an Airport/Heliport Environment but not in Class B, C or D airspace, the initial ARC (iARC) is therefore ARC-c.

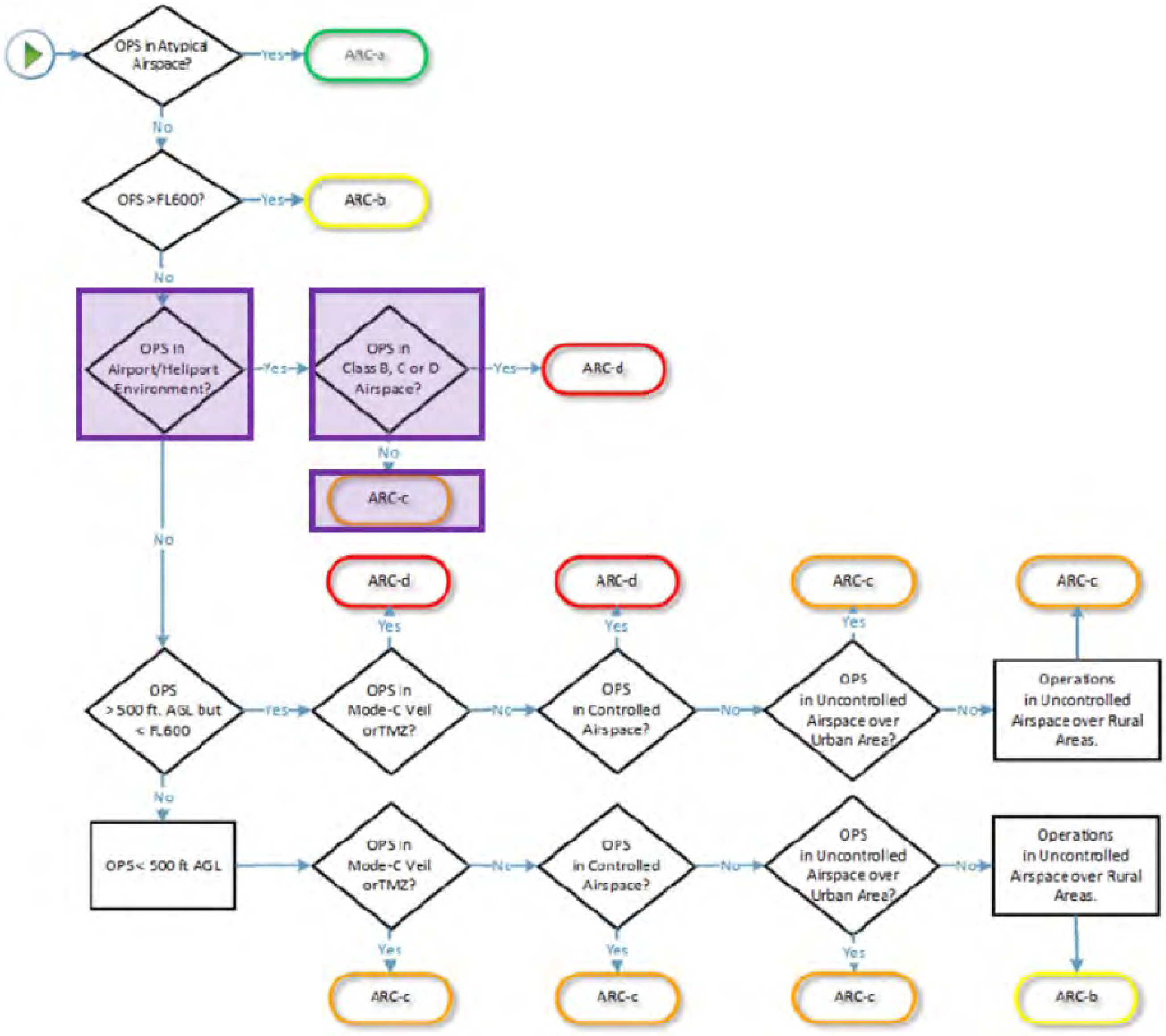

Figure 21 - ARC Flowchart for example 3, Source: JARUS guidelines