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Federal Office of Civil Aviation FOCA
UAS Authorization and Oversight

FOCA GM

Guidance **M**aterial

How to apply for an operational authorisation based on a Specific Operational Risk Assessment (SORA)

Guidance to Step #4 - Determination of the Initial Air Risk Class (ARC)

Scope	JARUS SORA v2.0 AMC and GM to Implementing Regulation (EU) 2019/947 Art. 11 This GM extends FOCA-UAS-GM-Part1
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0 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.

0.1 Terms and Conditions

The use of the male **gender** should be understood to include male and female persons.

The most frequent **abbreviations** used by the **EASA** are listed here: easa.europa.eu/abbreviations.

When used throughout the GM/INFO 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.

0.2 Disclaimer

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

Article 11 of the Implementing Regulation (EU) 2019/947 as well as the related AMC and GM is based on JARUS SORA V2.0 as of September 2021. The *applicability of Article 11 of (EU) 2019/947 is subject to the adoption of the European drone regulations in Switzerland.It is also used as baseline to this GM and any relevant differences are highlighted in the content of the GM.*

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, so it should not be understood as the only way to comply with regulatory requirements. An applicant can provide alternative means of complying with the requirements as long as there is enough evidence that an equivalent level of safety is being achieved.

0.3 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 (27.09.2022)

[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 (27.09.2022)

Note: AMC to Art. 11 of (EU) 2019/947 is used as baseline to this guidance material, however its applicability is subject to the adoption of the European drone regulations in Switzerland.

0.4 Purpose of this GM

The guidance material contained in this document is intended to complement and, when applicable, clarify the information in the JARUS documents *JARUS guidelines on Specific Operations Risk Assessment (SORA)* and *JARUS Guidelines on SORA - Annex C*, which can be found on jarus-rpas.org/content/jar-doc-06-sora-package [online] Available (27.09.2022).

0.5 Scope

This GM extends the “Guidance to Application for an Operational Authorization Part 1” (Doc. Ref. FOCA-UAS-GM-Part1, Available on FOCA Website) by providing further guidance to section 4. Step #4 – Assessing the air risk.

1 Air Risk Class

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 (this step is optional).

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.

ARC-a is generally defined as airspace where the risk of a collision between a UAS and a manned aircraft is acceptable without the addition of any tactical mitigation.

ARC-b, ARC-c, ARC-d are generally defined as volumes of airspace with increasing risk of a collision between UAS and manned aircraft.

During the UAS operation, the operational volume may span many different airspace environments. The applicant needs to perform an air risk assessment for the entire range of the operational volume.

Regarding the semantic model described in the SORA methodology, it is important to understand that the ARC considers the entire operational volume (flight geography and contingency volume) in both **horizontal and vertical dimensions** (blue volume in Figure 1).

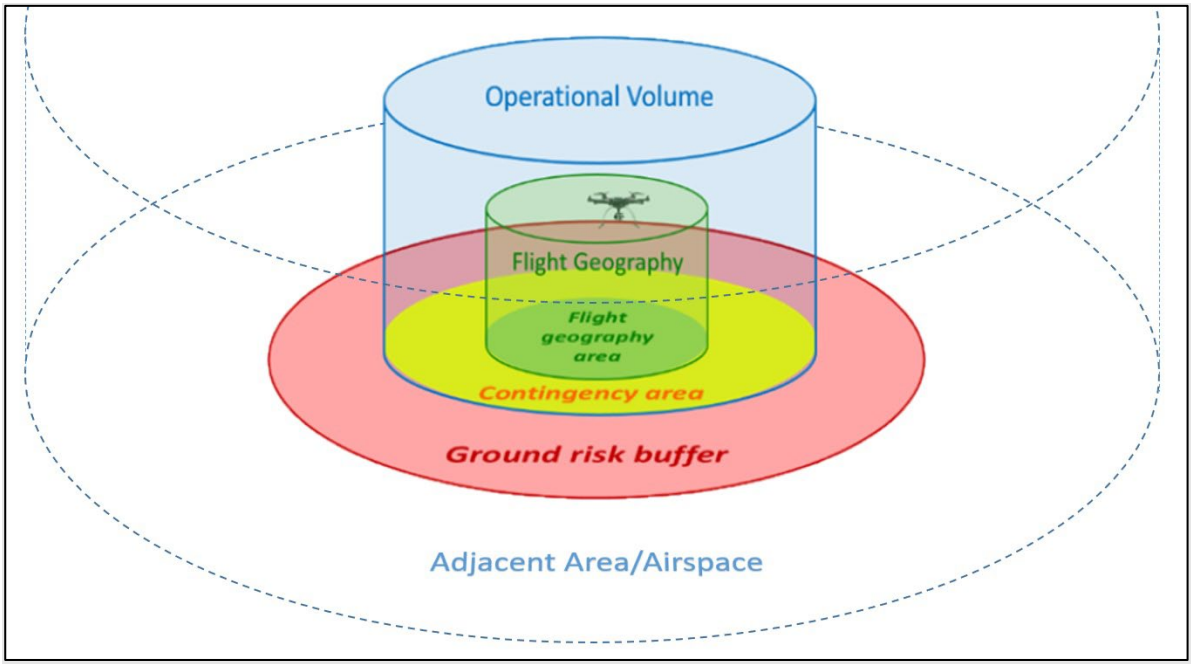


Figure 1: SORA semantic model

2 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.

2.1 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 600m (2000ft) 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.

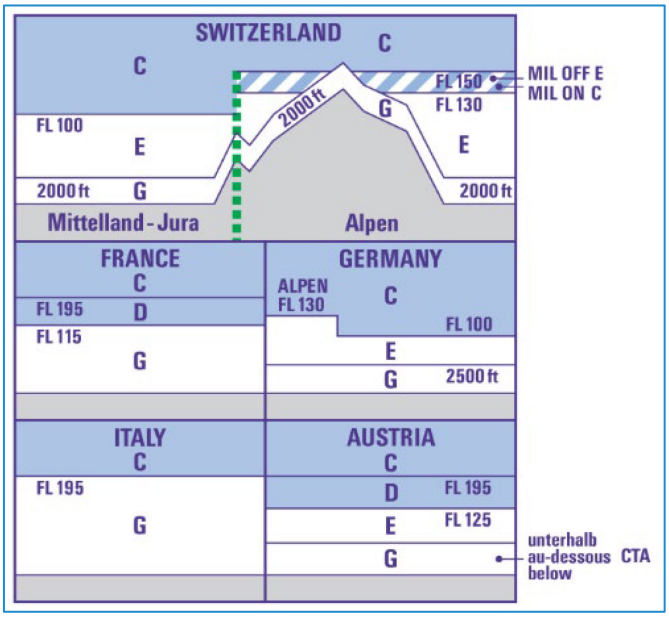


Figure 2 Airspace Classes Overview, Source: ICAO Chart Switzerland

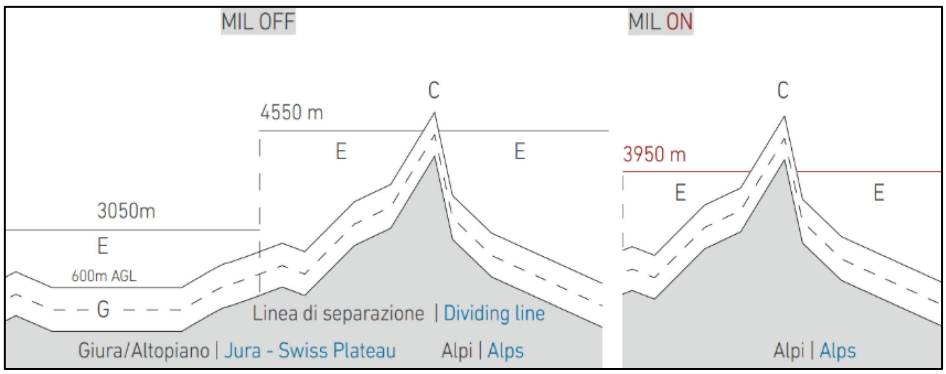


Figure 3 Airspace Classes in Switzerland, Source: SHV

2.2 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 1013.25hPa.

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.

2.3 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: LS-D, an airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Restricted Area: LS-R, 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: LS-P, 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.

2.4 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.

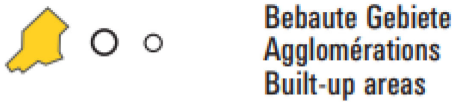
2.5 Additional Information

Population information:

Normal, manned VFR flights must maintain a minimum altitude of 1000ft over urban areas and 500ft 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 3000ft horizontally and ±350ft 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.

3 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:

3.1 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.

3.2 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.

3.3 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 500ft 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.

3.4 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.

3.5 Mountain landing sites

Mountain landing sites are landing sites outside of aerodromes - i.e. without infrastructure - and at an altitude of more than 1100 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

3.6 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)

3.7 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

4 Identification with JARUS flowchart

The ARC flowchart shown in Figure 5 below can be used to determine the initial Air Risk Class (iARC). 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 of SORA methodology).

As shown in Figure 4 below, the area considered to determine the ARC includes the “Flight Geography” and the “Contingency Volume”, excluding the optional air risk buffer.

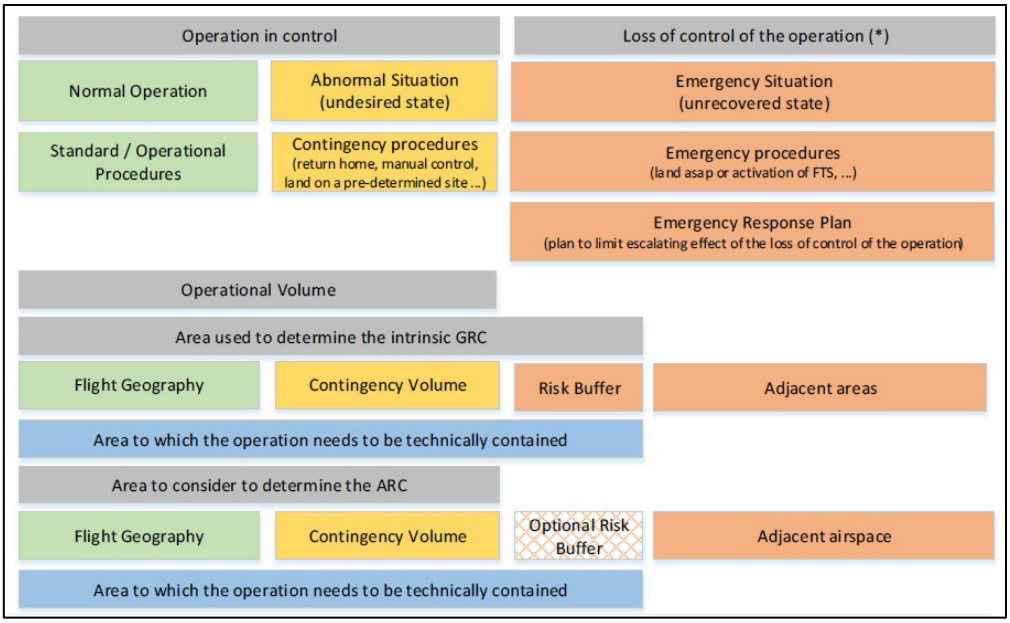


Figure 4 SORA semantic model, Source: JARUS guidelines

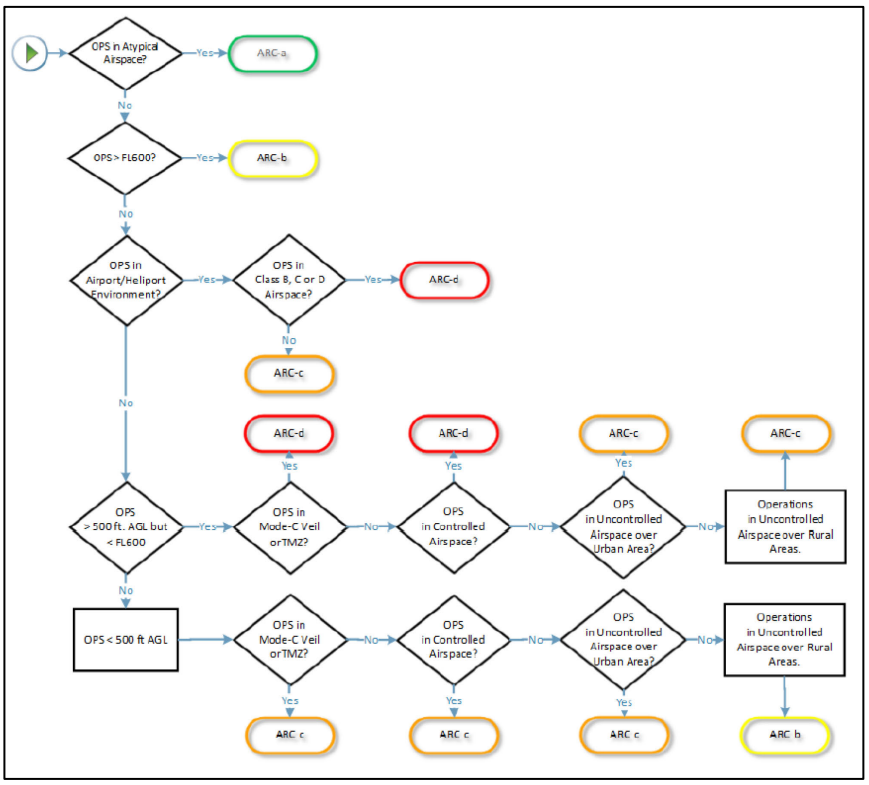


Figure 5 ARC identification flowchart, Source: JARUS guidelines

5 Example Cases

5.1 Example 1 – OPS < 500ft AGL in uncontrolled airspace over rural area

In this example, the flight takes place in Tafers (FR) at a maximum altitude of 120m AGL (400ft).

As it can been seen in Figure 6, by consulting the ICAO map and the RPAS map, we can see that the operational volume is situated within uncontrolled airspace, in airspace class G. The operation is not contained in any urban area (shown in yellow on the ICAO map). Therefore, the operation takes place in an uncontrolled airspace over rural area.

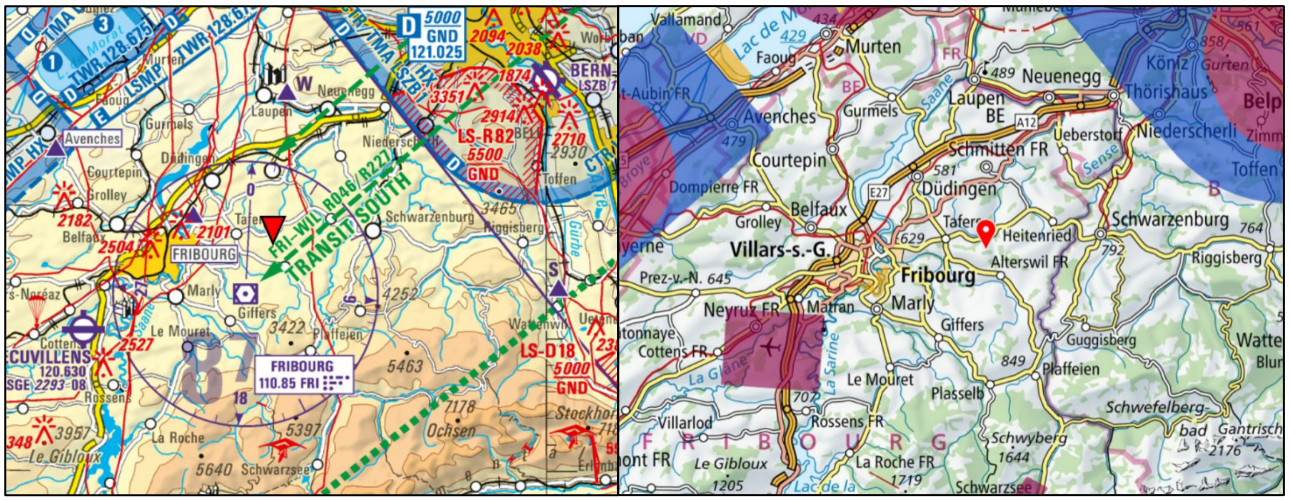


Figure 6 ICAO chart and RPAS restrictions map for example 1, Source: map.geo.admin

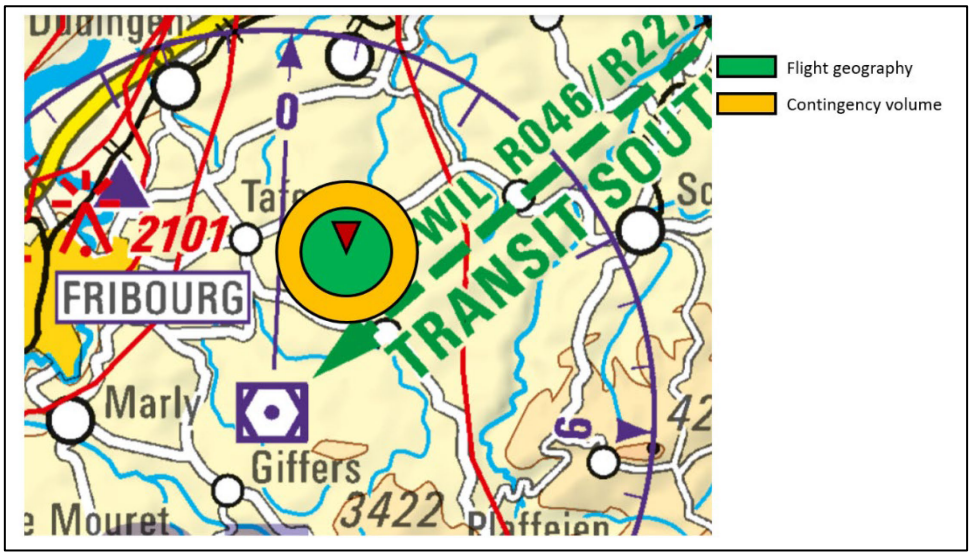


Figure 7 Illustration of potential operational volume for example 1, Source: map.geo.admin

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

As assessment of the local conditions (along the considerations of Chapter 4 above) showed that there are no further local traffic conditions that impact the operation.

Therefore the initial ARC remains ARC-b.

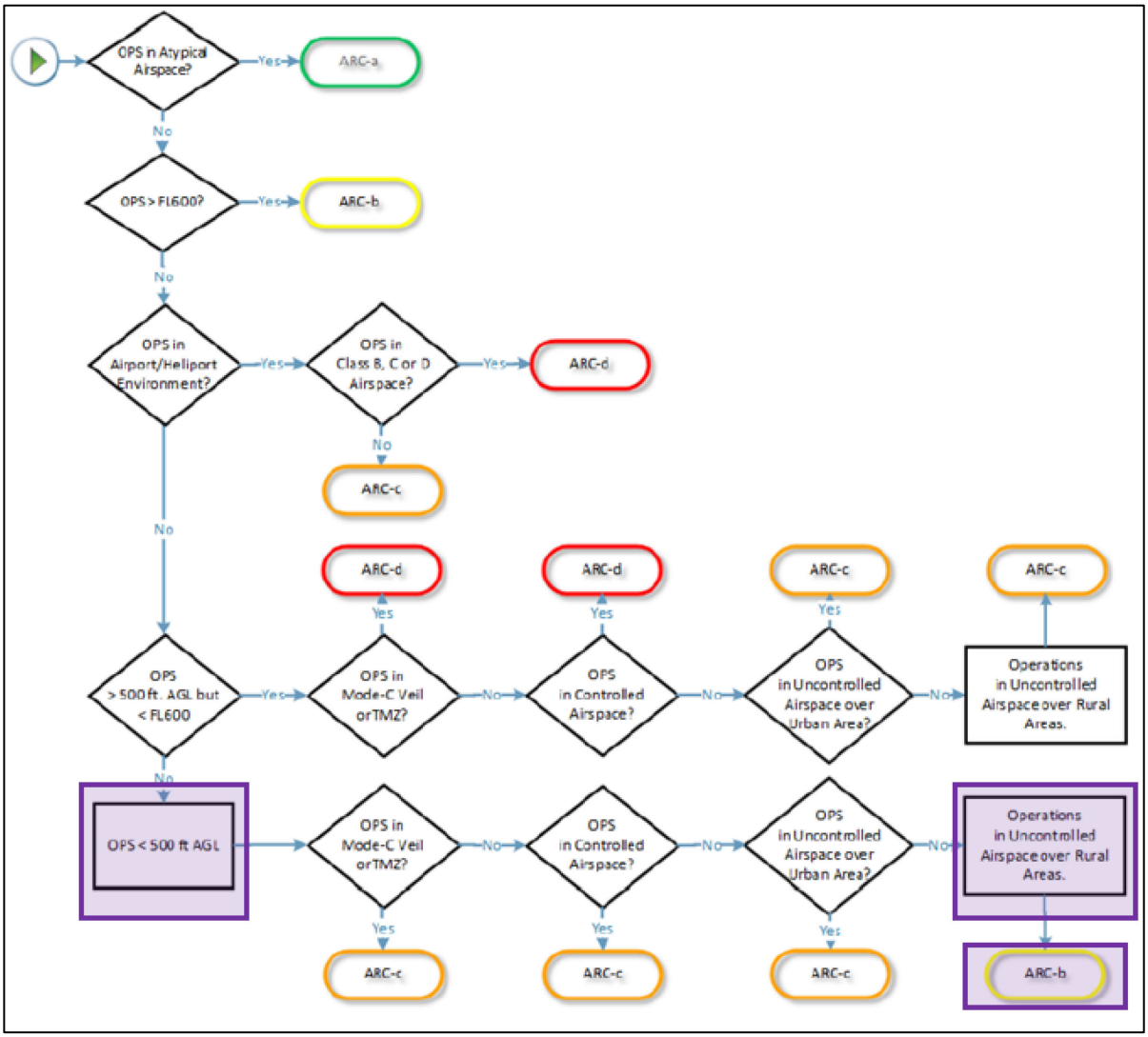


Figure 8 ARC Flowchart for example 1, Source: JARUS guidelines

5.2 Example 2 – 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.

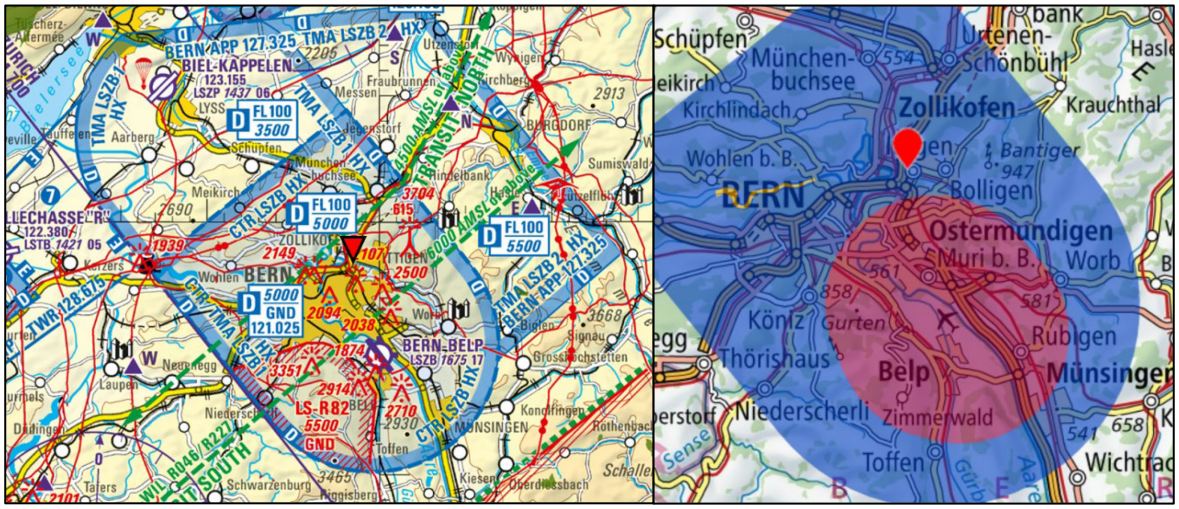


Figure 9 ICAO chart and RPAS restrictions map for example 2, Source: map.geo.admin

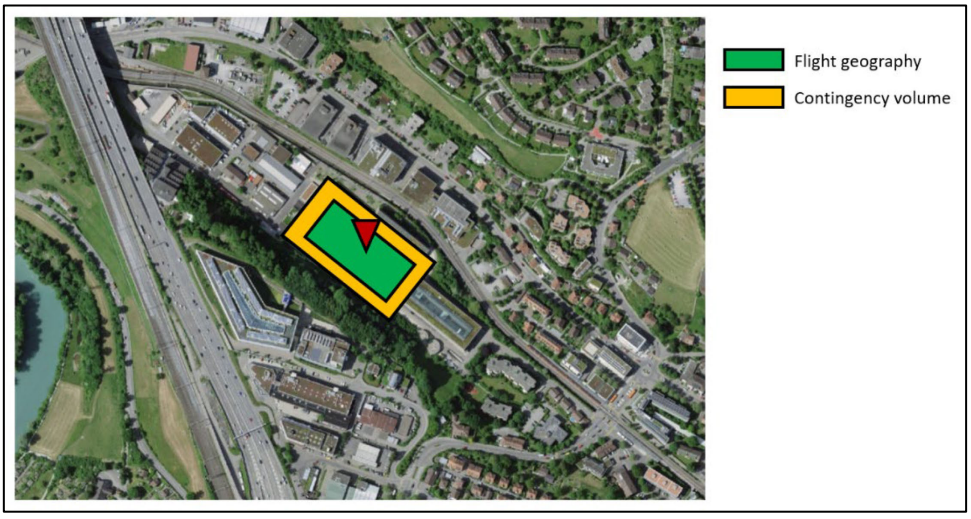


Figure 10 Illustration of potential operational volume for example 2, Source: map.geo.admin

Following the flowchart in Figure 13, we can identify that as the operation takes place below 500ft AGL and in controlled airspace, the initial ARC (iARC) is therefore ARC-c.

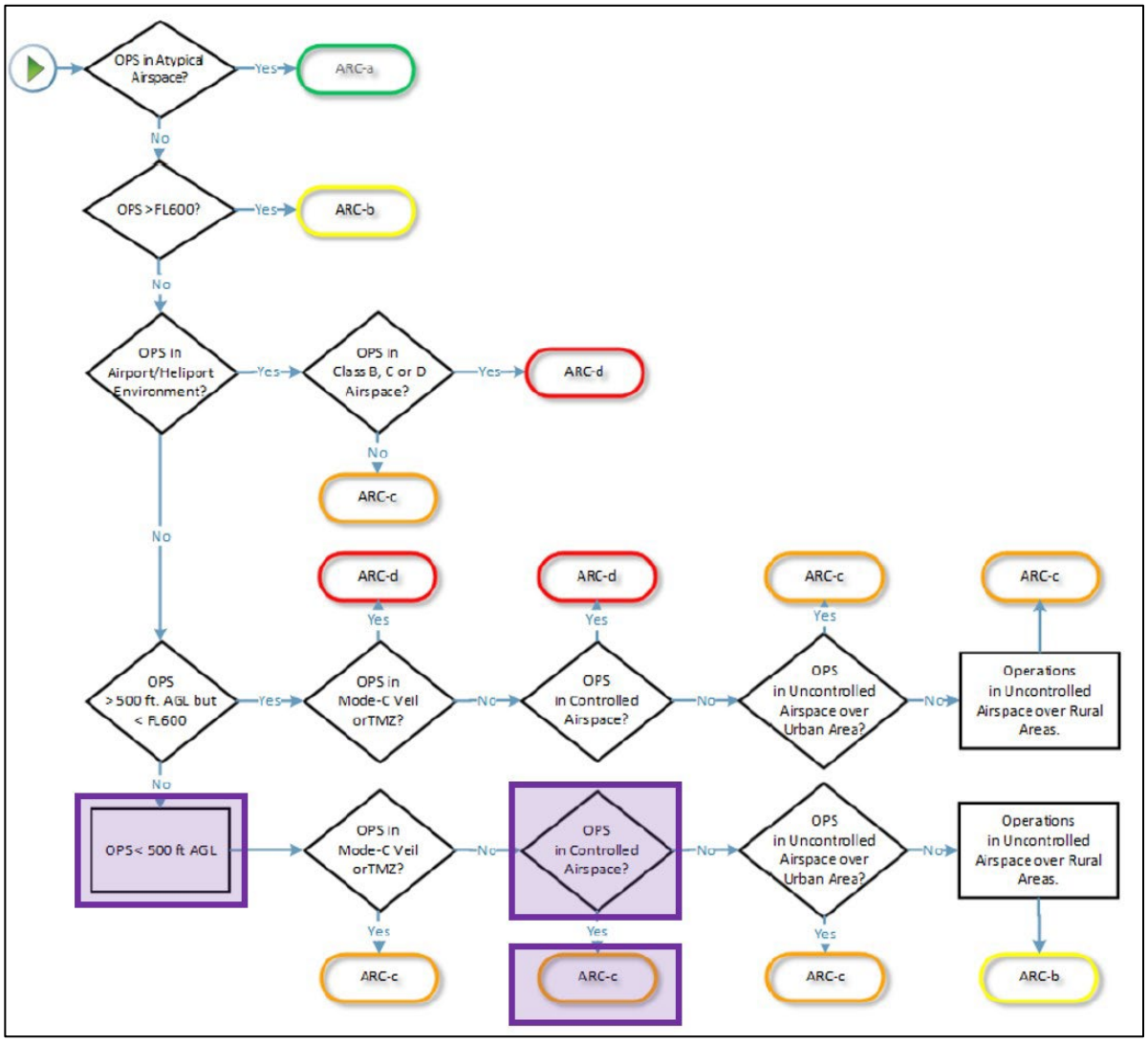


Figure 11 ARC Flowchart for example 2, Source: JARUS guidelines

5.3 Example 3 – 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.

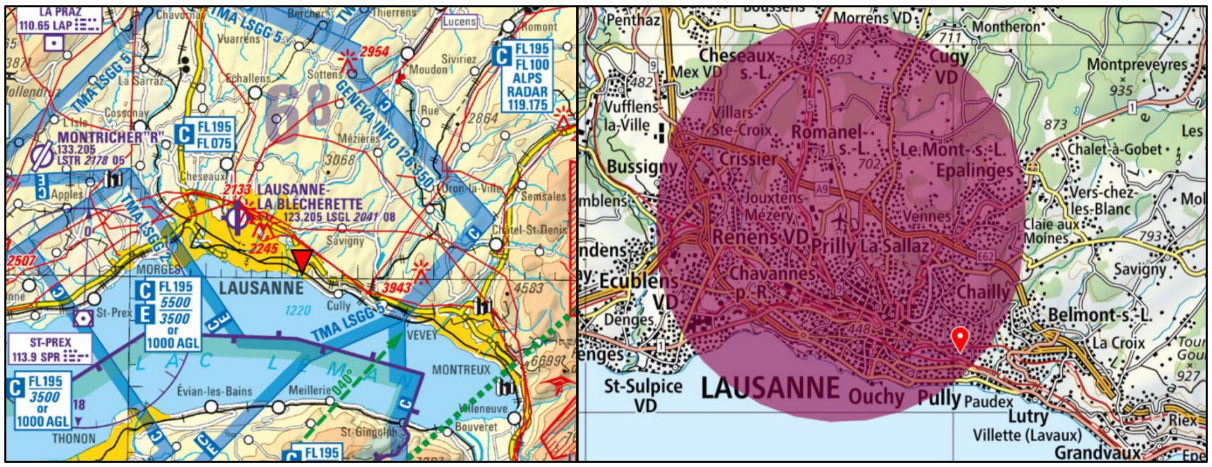


Figure 13 ICAO chart and RPAS restrictions map for example 3, Source: map.geo.admin

Figure 12 Illustration of potential operational volume for example 3, Source: map.geo.admin

Following the flowchart in Figure 14, 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.

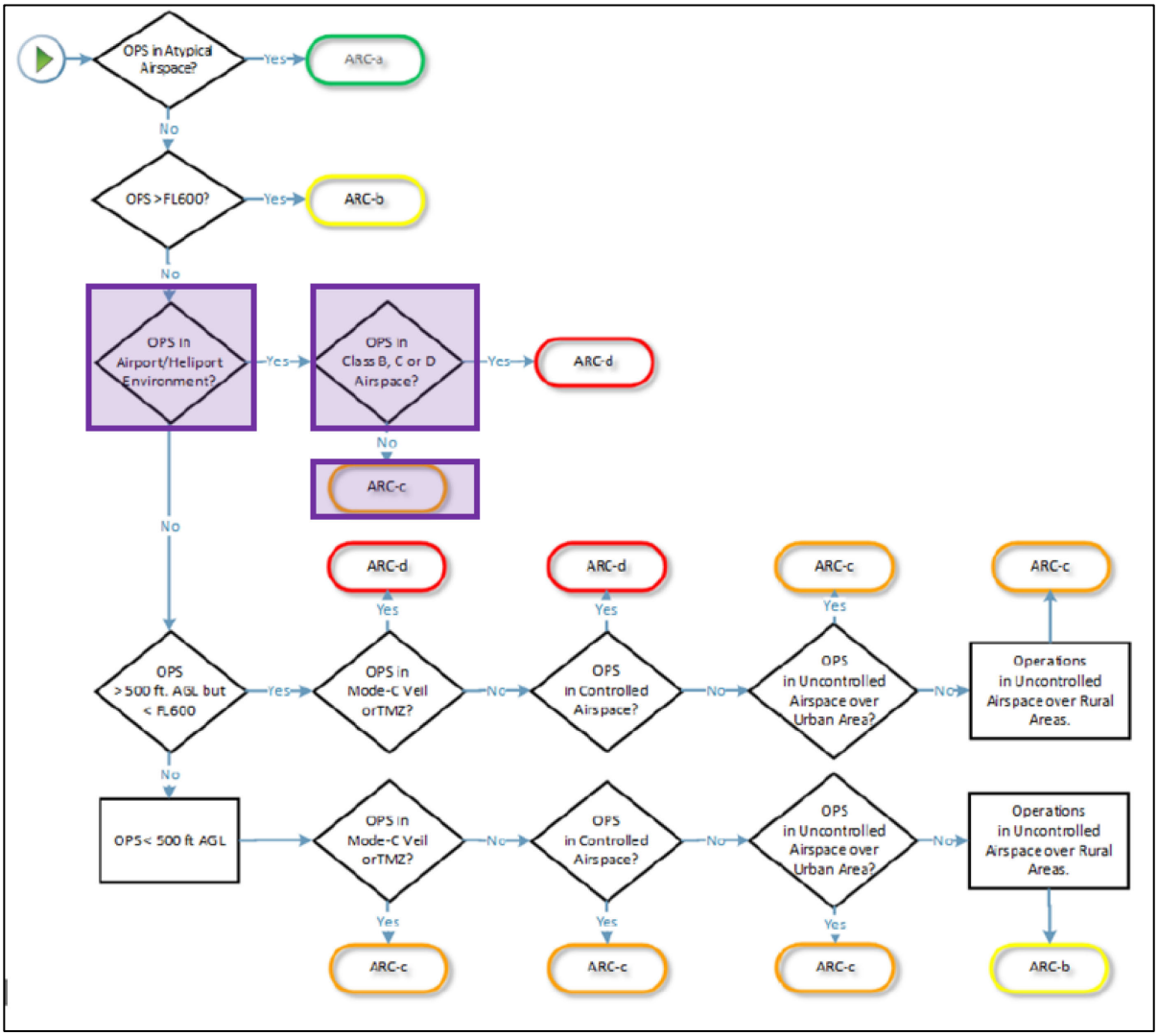


Figure 14 ARC Flowchart for example 3, Source: JARUS guidelines