
Approved by: Ordinance No. 1480/SAR, of May 2, 2017.

Subject: Remotely Piloted Aircraft System Design
Authorization - Technical Requirements.

Source: GTPN/SAR

1 OBJETIVO

1.1.1 This Supplementary Instruction - IS is intended to provide information on the demonstration of compliance with the requirements of sections E94.405 and E94.407 of Subpart E of the Brazilian Special Civil Aviation Regulation No. 94 - RBAC-E 94.

1.1.2 This IS describes an acceptable means, but not the only means to obtain the design authorization.

2 REVOCATION

2.1.1 N/A

3 FUNDAMENTALS

3.1.1 Art. 66, § 1 of Law no. 7,565, of December 19, 1986 (Brazilian Code of Aeronautics - CBAer), states that it is the duty of the aeronautical authority to promote and establish minimum safety standards for the design of aircraft and other aeronautical components.

3.1.2 Art. 8, XVII of Law No. 11,182, of September 27, 2005, provides jurisdiction to the National Civil Aviation Agency - ANAC as civil aviation authority to approve and issue certificates, attestations, approvals and authorizations related to the activities of the civil aviation flight safety system.

3.1.3 Resolution 30, of May 21, 2008, considering the wording given by Resolution no. 162 of July 20, 2010, establishes in its art. 14 that ANAC may issue IS to clarify, detail and guide the application of the requirement set in a RBAC.

3.1.4 Art. 14 of Resolution 30, of May 21, 2008, modified by Resolution No. 162, of July 20, 2010, also determines in its Paragraph 1 that the applicant that intends, for any purpose, to demonstrate compliance with the requirement set forth in a RBAC may adopt the means and procedures previously specified in IS or present duly justified alternative means or procedures, requiring, in that case, the analysis and express agreement of the competent ANAC body. Paragraph 2 of the same article determines that the alternative means or procedure must guarantee a level of safety equal to or greater to the one established by the applicable requirement or to achieve the objective of the procedure normalized in the IS.

4 DEFINITIONS

4.1.1 N/A

5 DEVELOPMENT OF THE SUBJECT

5.1 Applicability

5.1.1 This IS is applicable to any person wishing to demonstrate compliance with the requirements of sections E94.405 and E94.407 of Subpart E of RBAC-E94. The authorization of the RPAS design, by ANAC, is mandatory as established on the requirement RBAC-E 94.401(a).

5.2 Important points about RPAS design authorization

5.2.1 Due to the wide variety of aircraft types, construction methods and possible operations, there may be variations in methods related to demonstrating compliance with the requirements for each RPAS project. Thus, the potential developer of a RPAS is encouraged to consult ANAC before starting a design.

5.3 Confidentiality

5.3.1 All technical data presented to GGCP to substantiate the authorization of a RPAS design are considered property of the holder of the design and therefore of reserved character and can not therefore be disclosed or used by third parties, except with express authorization from its holder.

5.4 Demonstration of compliance with the technical requirements

5.4.1 RPAS flight manual - RBAC-E 94.405(a)(1)

5.4.1.1 Except when explicitly mentioned in this section, this Supplementary Instruction identifies the ASTM F2908-14, Standard Specification for Aircraft Flight Manual (AFM) for a Small Unmanned Aircraft System (sUAS), as containing an acceptable means by ANAC to develop a RPAS flight manual.

5.4.1.2 The RPAS flight manual shall include all procedures - normal, abnormal or emergency - that require a remote pilot action, in accordance with the safety analysis report required by requirement RBAC-E 94.405(a)(3) and any other safety assessment conducted by the applicant.

5.4.1.3 It is not required by ANAC that the RPAS flight manual include the information on handling, servicing and instructions for maintenance and continued airworthiness as set forth in section 7.10 of ASTM F2908-14, however, it may be adopted by the applicant, provided that it complies with RBAC-E 94.405(a)(2). For more information, see section 5.4.2 of this Supplemental Instruction.

5.4.2 Maintenance manual - RBAC-E 94.405(a)(2)

5.4.2.1 The required maintenance manual shall be prepared by the applicant from a maintenance and continued airworthiness program to enable the operator to maintain RPAS under safe operating conditions.

5.4.2.2 This Supplementary Instruction identifies the section 5 of the ASTM F2909-14, Standard Practice for Continued Airworthiness and Maintenance of Small Unmanned Aircraft Systems (ITS) as containing an acceptable means by ANAC to prepare a maintenance and continued airworthiness program for a RPAS.

5.4.2.3 The maintenance manual should also establish proper registration for all maintenance tasks. Section 6 of ASTM F2909-14 presents an acceptable means by ANAC for the elaboration of RPAS maintenance records.

5.4.2.4 The maintenance manual should list all part numbers of all components, including software and configurations, authorized to be used in the design

5.4.3 Safety analysis report - RBAC-E 94.405(a)(3)

5.4.3.1 The safety analysis report shall contain at least the following information:

- a) A description of the systems that impact the RPAS flight safety;
- b) A comprehensive analysis of potentially dangerous events and their effects;
- c) A list of alarms provided in the Remote Pilot Station - RPS;
- d) Procedures to be followed in case of malfunctions or failures;
- e) Identification of the procedures to be adopted, automatically or initiated by the remote pilot, in the following cases of failure:
 - I - Malfunctioning of a flight control actuator;
 - II - Loss of autopilot;
 - III - Loss of an engine;
 - IV - Complete loss of the electrical system of the Remotely Piloted Aircraft - RPA;
 - V - Complete loss of RPS electrical system;
 - VI - Fire in the RPA;
 - VII - Fire in the RPS;
 - VIII - Loss of navigation capability;
 - IX - Intentional (unlawful) interference in the command and control link;
 - X - Unintentional interference in the command and control link;
 - XI - Loss of communication with air traffic control;
 - XII - Loss of communication between the remote pilot and other persons involved in the RPA operation;
 - XIII - Loss of pressure or rupture in the gas envelope, if applicable;
 - XIV - Any other failure for which it is necessary or convenient to establish contingency procedures as identified in the list of potentially dangerous events and their effects.

5.4.3.2 All cases listed above should be mitigated by incorporating design features or operating procedures, preventing them from resulting in events that have the potential to cause serious or fatal injury to persons directly involved in the operation or not.

5.4.4 Operation of the command and control link - RBAC-E 94.405(b)

5.4.4.1 The applicant shall provide an analysis based on equipment specifications (radios, antennas) used in the RPA and the RPS and data obtained during flight tests, demonstrating that the largest distance between RPA-RPS specified in the operational limitations of the RPAS is adequate for the operation of the system;

5.4.4.2 It shall be demonstrated by means of tests that the communication system used by the command and control link, under representative operational environmental conditions, is able to operate satisfactorily, transmitting and/or receiving the amount of information required for safe flight, at a distance at least 20% greater than the maximum range specified between the RPS and the RPA. At this distance 360° curves to the right and to the left must also be made with roll angles equal to or greater than 10°.

5.4.4.3 The effects of climatic conditions and topology should be taken into account in determining the maximum range of the command and control link.

5.4.4.4 If the project provides for switching between RPSes during the RPA operation, it must be demonstrated that the switching takes place properly, without oscillations or disturbances affecting the safe flight of the RPA.

5.4.4.5 For authorizing RPAS intended for operation Beyond Visual Line of Sight - BVLOS, the following additional items apply:

- a) The analysis conducted in accordance with subparagraph 5.4.4.1 should take into consideration the potential sources of degradation in the Command and Control – C2 link operation, such as shading of the antennas during curves and attitude changes in RPA, formation of bad weather, natural or artificial obstacles and effects of Earth curvature, among others applicable. The tests shall, as far as possible, reproduce such conditions;
- b) Proper operation of the C2 link(s) shall not be affected by failures of non-required or non-essential systems;
- c) The applicant shall demonstrate that the C2 link(s) have characteristics that ensure reliability and minimize system vulnerability to harmful radio interference. In order to do so, it is recommended that the RPAS intending to operate BVLOS use radio frequencies intended primarily assigned for the Aeronautical Mobile Service (AMS), the Aeronautical Mobile (Route) Service (AM(R)S), the Aeronautical Mobile Satellite Service (AMSS) and the Aeronautical Mobile Satellite Route Service (AMS(R)S), or any other radiofrequency primarily assigned to the operation of the RPAS;
- d) The C2 link (s) shall incorporate features such as data encryption and frequency hopping that minimize the risks associated with acts of unlawful interference.

NOTE 1 - ASTM F-3002, Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS), contains adequate guidance on the design of command and control links.

5.4.5 Ground or flight demonstrations - RBAC-E 94.405(c)

5.4.5.1 Flight demonstrations, when required, shall consist of the following:

- a) A minimum of two flights, in which the operating envelope, performance and flight characteristics determined in design are demonstrated;
- b) Demonstrations of failure cases detailed in the safety analysis report that can be demonstrated without compromising the integrity of RPAS or third-party safety.

5.4.5.2 Additional demonstrations may be requested for purposes of demonstrating compliance with applicable requirements.

5.4.5.3 Engineering inspection may be requested for the purpose of assessing whether the system and its components are compatible and comply with airworthiness requirements.

5.4.6 Relevant information and alerts for operations BVLOS or above 400 feet AGL - RBAC-E 94.407(a)

5.4.6.1 For those RPAS intended to operate BVLOS, at least the following information must be presented in the RPS throughout the flight to the remote pilot:

- a) RPA front-view video image;
- b) RPA barometric altitude, if authorization is requested for flights above 400 feet AGL;
- c) RPA geometric height in relation to ground level;
- d) RPA roll, pitch and heading angles;
- e) RPA flight direction;
- f) Flight speeds required for safe operation of RPA;
- g) Essential parameters of the RPA engine;
- h) RPA autonomy indication and alerts (ex: fuel level and battery charge);
- i) Indication of the quality of the command and control link (eg signal strength, bit error rate - BER, etc.);
- j) Current position of the RPA superimposed on a map that also indicates the area where the flight was authorized.

5.4.6.2 It should be demonstrated that information refresh rates and delays in presenting flight information do not compromise the pilot's ability to control the RPA.

- 5.4.6.3 The pilot should be provided with alerts on the occurrence of events that may affect the safe operation of the RPA, such as:
- a) Degradation of the RPAS position and navigation information;
 - b) Degradation of the command and control link;
 - c) Quantity of fuel that compromises the safe operation of the RPA;
 - d) Low charge of batteries related to propulsion, command or control;
 - e) Alerts that indicate a risk of exceeding the limits of the area where the flight was authorized;
 - f) Alerts that indicate a risk of exceeding the height or altitude limits in which the flight was authorized;
 - g) Other alerts that have been defined as relevant from the RPAS design risk analysis.
- 5.4.6.4 It should be demonstrated that the alerts are always presented in sufficient time so that the pilot can take the necessary measures in relation to the event that occurred. Delays in presenting the alerts should be taken into account in this demonstration.
- 5.4.6.5 For Class 2 or 3 RPAS intended for operation in Visual Line of Sight - VLOS and at maximum height exceeding 400 feet AGL, the following items are applicable: items (b), (c) and (h) of paragraph 5.4.6.1, the entire paragraph 5.4.6.2, items (c), (d), (f) and (g) from paragraph 5.4.6.3 and the entire paragraph 5.4.6.4.
- 5.4.7 Navigation system for operations BVLOS - RBAC-E 94.407(b)**
- 5.4.7.1 The applicant shall establish in the AFM the demonstrated performance limits of the navigation system in the horizontal and vertical plane, which shall be reflected in the BVLOS flight planning procedures in terms of distances in relation to danger areas and safe operating altitudes.
- 5.4.7.2 The applicant shall demonstrate that the total system errors in the longitudinal and transverse axes in relation to the flight path (cross track and along track) are smaller than the value specified in the horizontal plane for 95% of the flight time.
- 5.4.7.3 The applicant shall demonstrate that the total system error on the vertical axis is less than the value specified in the vertical plane during 99.7% of the flight time.
- 5.4.7.4 The applicant shall establish emergency procedures for cases that result in degradation of navigation capacity (eg loss of a navigation source) appropriate to the functional capabilities of each equipment used.
- 5.4.7.5 The design of navigation systems and other systems that support their operation (such as power supply systems) must meet the criticality levels identified in the Risk Analysis Report, taking into account the scenarios in which RPA will operate BVLOS.
- 5.4.7.6 RPAS must have at least two navigation systems with a discrepancy alert between data from different sources.

5.4.7.7 Systems whose loss of navigation capacity is classified as catastrophic may not have their navigation capability based solely on GNSS.

5.4.8 Emergency recovery capability for operations BVLOS or above 400 feet AGL - RBAC-E 94.407(c)

5.4.8.1 The emergency recovery capability should aim to prevent risks to third parties and should consist of:

- a) A flight termination system, procedure or function that aims to terminate the flight immediately, or;
- b) An emergency recovery procedure that is implemented through pilot-initiated commands or embedded systems, which may include a preprogrammed automatic course to reach a predefined landing area, or;
- c) Any combination of the above options.

5.4.8.2 The emergency recovery capability must be effective in dealing with the following failure scenarios:

- a) Loss of C2 link;
- b) Loss of navigation capability;
- c) Loss of primary electric source; and
- d) Other failures for which the safety analysis report has pointed to the emergency recovery as an effective mitigating action.

5.4.8.3 The emergency recovery capability shall be achievable throughout the flight envelope in the most adverse combination of environmental and operational conditions.

5.4.8.4 The emergency recovery capability shall be safeguarded from interference that may result in inadvertent or unauthorized operation.

5.4.8.5 If it requires electrical power to operate, the emergency recovery capability must be fed by the electric bus that provides the highest reliability for operation.

5.4.8.6 Emergency recovery capability should be possible after loss of the primary electrical system.

5.4.8.7 The use of explosives to perform the in-flight destruction of the RPA is not an acceptable means to comply with this requirement.

5.4.9 External lighting system for operations BVLOS or above 400 feet AGL - RBAC-E 94.407(d)

5.4.9.1 In accordance with requirement RBAC-E 94.407 (d), all RPAS intended for operation BVLOS must have an adequate aircraft lighting system. This IS item has the purpose of guiding the applicant regarding the definition of adequate lighting, associated with the context of operation of the RPAS.

5.4.9.2 In addition, in compliance with requirement RBAC-E 94.403(d), this section is also applicable to all Class 2 or 3 RPAS intended for operation VLOS whose maximum operating height exceeds 400 ft AGL.

5.4.9.3 Thus, as an acceptable means to fulfill this requirement:

- a) The external lighting system of the RPA must be in operation for both daytime and night operations. The lighting shall include the installation of stroboscopic white or red strobe light.
- b) The RPA lighting system should allow an effective visualization of the RPA so that the aircraft is sighted by people who may be close to the RPA site of operation. It shall be demonstrated that the aircraft is visible even at night at such a distance as to allow the aircraft to be seen at least 30 seconds before reaching the point where it was sighted, taking into account for this the maximum speed at which the aircraft may fly.
- c) Any RPA operating above 400 feet in relation to the ground must have a lighting system that allows the RPA to be viewed at a minimum distance of 2 km, considering a slope of up to 5 degrees relative to the RPA horizontal flight plane. As an alternative to this item, the applicant is allowed to comply with the requirements of RBAC 23.1401 or 27.1401 as applicable.

6 APPENDICES

APPENDIX A – LIST OF REDUCTIONS

7 FINAL DISPOSITIONS

7.1.1 The missing cases will be settled by ANAC.

7.1.2 This IS comes into force on the date of its publication.

APPENDIX A – LIST OF REDUCTIONS**A.1 Acronyms**

a)	AFM	<i>Aircraft Flight Manual</i>
b)	ANAC	Agência Nacional de Aviação Civil
c)	BER	<i>Bit Error Rate</i>
d)	BVLOS	<i>Beyond Visual Line of Sight</i>
e)	C2	Comando e Controle
f)	CBAer	Código Brasileiro de Aeronáutica
g)	IS	Instrução Suplementar
h)	RBAC	Regulamento Brasileiro de Aviação Civil
i)	RPA	<i>Remotely Piloted Aircraft</i>
j)	RPAS	<i>Remotely Piloted Aircraft System</i>
k)	RPS	<i>Remote Pilot Station</i>
l)	sUAS	<i>Small Unmanned Aircraft System</i>
m)	VLOS	<i>Visual Line of Sight</i>