



August 2019

NAM-CATS 101 Remotely Piloted Aerial Operations

DRAFT for Comments (ito Part 3 of NAMCARS 2018)

INTRODUCTION

1. General

Section 227 of the Civil Aviation Act of 2016 empowers the Executive Director for Civil Aviation to issue technical standards for civil aviation on the matters which are prescribed by regulation. Draft Regulations Part 101 (on RPAs and RPA systems) have been issued for comment and must be read with these (draft CATs).

2. Purpose

Document NAM-CATS 101 contains the standards, rules, requirements, methods, specifications, characteristics and procedures which are applicable in respect of air ambulance operations.

Each reference to a technical standard in this document is a reference to the corresponding regulation in the Civil Aviation Regulations (NAMCARS 2001, as amended). For example, technical standard 101.02.3 refers to regulation 3 of Subpart 02 of Part 101 the NAMCARS.

The abbreviation “CAR” is used throughout this document when referring to any regulation.

The abbreviation “TS” refers to any technical standard.

3. Schedules and notes

Guidelines and recommendations in support of any particular technical standard are contained in schedules to, and/or notes inserted throughout, the technical standards.

101.01.1

APPLICABILITY

1. NAM-CAR 101.01.1 (2)(a) specifies that the requirements for remotely piloted aerial operations do not apply to model/toy aircraft operated for recreational purposes . Persons operating such aircraft should refer to Part 107 for the applicable requirements.

101.02.1

GENERAL OPERATING RULES

1. In order to comply with the requirements of subregulation 101.02.1 (3), a request for a foreign RPAS owner's or operator's authorisation to operate an RPAS inside the territory of Namibia shall be made to the Executive Director including the following items:
 - (a) name and contact information of the operator;
 - (b) RPA characteristics (type of aircraft, maximum certificated take-off mass, number of engines, wing span);
 - (c) copy of certificate of registration *;
 - (d) aircraft identification to be used in radiotelephony, if applicable;
 - (e) copy of the certificate of airworthiness *;
 - (f) copy of the RPAS operator certificate *;
 - (g) copy of the remote pilot(s) licence;
 - (h) copy of the aircraft radio station licence, if applicable;
 - (i) description of the intended operation (to include type of operation or purpose), flight rules, visual line-of-sight (VLOS) operation if applicable, date of intended flight(s), point of departure, destination, cruising speed(s), cruising level(s), route to be followed, duration/frequency of flight;
 - (j) take-off and landing requirements;
 - (k) RPA performance characteristics, including:
 - i) operating speeds;
 - ii) typical and maximum climb rates;
 - iii) typical and maximum descent rates;
 - iv) typical and maximum turn rates;
 - v) other relevant performance data (e.g. limitations regarding wind, icing, precipitation); and
 - vi) maximum aircraft endurance;
 - (l) communications, navigation and surveillance capabilities, where applicable:
 - i) aeronautical safety communications frequencies and equipment, including:

- ATC communications, including any alternate means of communication;
 - command and control links (C2) including performance parameters and designated operational coverage area;
 - communications between remote pilot and RPA observer, if applicable;
- ii) navigation equipment; and
- iii) surveillance equipment (e.g. SSR transponder, ADS-B out);
- (m) detect and avoid capabilities;
- (n) emergency procedures, including:
- i) communications failure with ATC;
 - ii) C2 failure; and
 - iii) remote pilot/RPA observer communications failure, if applicable;
- (o) number and location of remote pilot stations as well as handover procedures between remote pilot stations, if applicable;
- (p) document attesting noise certification that is consistent with the provisions of Annex 16, Volume 1, if applicable;
- (q) confirmation of compliance with national security standards, to include security measures relevant to the RPAS operation, as appropriate;
- (r) payload information/description; and
- (s) proof of adequate insurance/liability coverage.

Note: Items annotated * apply only where required by the Executive Director . These items do not normally apply to small RPAS operations in Namibia.

2. When certificates or other documents identified in paragraph 2 above are issued in a language other than English, an English translation shall be included.

101.02.3

CONDITION FOR SAFE OPERATION

1. An RPAs must be maintained in a condition for safe operation. Prior to flight, the remote PIC is responsible for conducting a check of the RPAs and verifying that it is actually in a condition for safe operation. This TS provides guidance on how to inspect and maintain an RPAS. Additionally, Appendix 3, RPAs Maintenance and Inspection Best Practices, contains expanded information and best practices for RPAs maintenance and inspection.
2. Maintenance. RPAs maintenance includes scheduled and unscheduled overhaul, repair, inspection, modification, replacement, and system software upgrades of the RPAs and its components necessary for flight. Whenever possible, the operator should maintain the RPAs and its components in accordance with manufacturer's instructions. The aircraft manufacturer may provide the maintenance programme, or, if one is not provided, the applicant may choose to develop one. See TS 101.02.2 for suggested benefits of record-keeping.

3. **Scheduled Maintenance.** The RPAs manufacturer may provide documentation for scheduled maintenance of the entire RPA and associated system equipment. There may be components of the RPAs that are identified by the manufacturer to undergo scheduled periodic maintenance or replacement based on time-in-service limits (such as flight hours, cycles, and/or the calendar-days). All manufacturer scheduled maintenance instructions should be followed in the interest of achieving the longest and safest service life of the RPAS.

If there are no scheduled maintenance instructions provided by the RPAs manufacturer or component manufacturer, the operator should establish a scheduled maintenance protocol. This may be achieved by documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure. Over time, the operator should then be able to establish a reliable maintenance schedule for the RPAs and its components.

4. **Unscheduled Maintenance.** During the course of a pre-flight inspection, the remote PIC may discover that an RPAs component is in need of servicing (such as lubrication), repair, modification, overhaul, or replacement outside of the scheduled maintenance period as a result of normal flight operations or resulting from a mishap. In addition, the RPAs manufacturer or component manufacture may require an unscheduled system software update to correct a problem. In the event such a condition is found, the remote PIC should not conduct flight operations until the discrepancy is corrected.
5. **Performing Maintenance.** In some instances, the RPAs or component manufacturer may require certain maintenance tasks be performed by the manufacturer or by a person or facility specified by the manufacturer. It is strongly recommended that the maintenance be performed in accordance with the manufacturer's instructions. However, if the operator decides not to use the facility or personnel recommended by the manufacturer and is unable to perform the required maintenance, the operator should consider the expertise of maintenance personnel familiar with the specific RPAs and its components. In addition, though not required, the use of licenced maintenance providers are encouraged, which may include repair stations, holders of AME licences, and persons working under the supervision of AMEs.

If the operator or other maintenance personnel are unable to repair, modify, or overhaul an RPAs or component back to its safe operational specification, then it is advisable to replace the RPAs or component with one that is in a condition for safe operation. It is important that all required maintenance be completed before each flight, and preferably in accordance with the manufacturer's instructions or, in lieu of that, within known industry best practices.

6. **Pre-flight Inspection.** Before each flight, the remote PIC shall inspect the RPAs to ensure that it is in a condition for safe operation, such as inspecting for equipment damage or malfunction(s). The pre-flight inspection should be conducted in accordance with the RPAs manufacturer's inspection procedures when available (usually found in the manufacturer's owner or maintenance manual) and/or an inspection procedure developed by the RPAs owner or operator.
7. **Creating an Inspection Programme.** As an option, the RPAs owner or operator may wish to create an inspection programme for their RPAS. The person creating an inspection programme for a specific RPAs may find sufficient details to assist in the development of a suitable inspection programme tailored to a specific RPAs in a variety of industry programmes.
8. **Tailored Pre-flight Inspection.** The pre-flight check as part of the inspection programme should include an appropriate RPAS pre-flight inspection that is tailored to the RPAS, programme, and operation to be performed prior to each flight. An appropriate pre-flight inspection should encompass the entire system in order to determine a continued condition for safe operation prior to flight.

9. Pre-flight Inspection Items. Even if the RPAs manufacturer has a written pre-flight inspection procedure, it is recommended that the remote PIC ensure that the following inspection items are incorporated into the pre-flight inspection procedure required by Part 101 to help the remote PIC determine that the RPAs is in a condition for safe operation. The pre-flight inspection should include a visual or functional check of the following items:
- (a) Visual condition inspection of the RPAS components;
 - (b) Airframe structure (including undercarriage), all flight control surfaces, and linkages;
 - (c) Registration markings, for proper display and legibility;
 - (d) Moveable control surface(s), including airframe attachment point(s);
 - (e) Servo motor(s), including attachment point(s);
 - (f) Propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.;
 - (g) Verify all systems (e.g., aircraft and control unit) have an adequate energy supply for the intended operation and are functioning properly;
 - (h) Avionics, including control link transceiver, communication/navigation equipment, and antenna(s);
 - (i) Calibrate RPAS compass prior to any flight;
 - (j) Control link transceiver, communication/navigation data link transceiver, and antenna(s);
 - (k) Display panel, if used, is functioning properly;
 - (l) Check ground support equipment, including take-off and landing systems, for proper operation;
 - (m) Check that control link correct functionality is established between the aircraft and the control system(CS);
 - (n) Check for correct movement of control surfaces using the CS;
 - (o) Check on-board navigation and communication data links;
 - (p) Check flight termination system, if installed;
 - (q) Check fuel for correct type and quantity;
 - (r) Check battery levels for the aircraft and CS;
 - (s) Check that any equipment, such as a camera, is securely attached;
 - (t) Verify communication with RPAS and that the RPAS has acquired GPS location from at least four satellites;
 - (u) Start the RPAS propellers to inspect for any imbalance or irregular operation;
 - (v) Verify all controller operation for heading and altitude;

(w) If required by flight path walk through, verify any noted obstructions that may interfere with the RPAS; and

(x) At a controlled low altitude, fly within range of any interference and recheck all controls and stability.

10. Benefits of Record-keeping. RPAs owners and operators may find record-keeping to be beneficial. This could be done by documenting any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations, and recording the time-in-service for that component at the time of the maintenance procedure. Over time, the operator should then be able to establish a reliable maintenance schedule for the RPAs and its components.

Record-keeping that includes a record of all periodic inspections, maintenance, preventative maintenance, repairs, and alterations performed on the RPAs could be retrievable from either hardcopy and/or electronic logbook format for future reference. This includes all components of the sRPAS, including: small RPA, CS, launch and recovery equipment, command-and-control (C2) link equipment, payload, and any other components required to safely operate the sRPAS.

Record-keeping of documented maintenance and inspection events reinforces owner/operator responsibilities for airworthiness through systematic condition for safe flight determinations. Maintenance and inspection record-keeping provides retrievable empirical evidence of vital safety assessment data defining the condition of safety-critical systems and components supporting the decision to launch. Record-keeping of an RPAs may provide essential safety support for commercial operators that may experience rapidly accumulated flight operational hours/cycles.

Methodical maintenance and inspection data collection can prove to be very helpful in the tracking of RPAs component service life, as well as systemic component, equipment, and structural failure events.

101.02.4

MEDICAL CONDITION

1. Being able to safely operate the RPAs relies on, among other things, the physical and mental capabilities of the remote PIC, person manipulating the controls, VO, and any other direct participant in the RPAs operation. Though the person manipulating the controls of an RPAs and VO are not required to obtain an aviation medical certificate, they may not participate in the operation of an RPAs if they know or have reason to know that they have a physical or mental condition that could interfere with the safe operation of the sRPAS.
2. Obvious examples of physical or mental incapacitations that could render a remote PIC, person manipulating the controls, or VO incapable of performing their RPAs operational duties include, but are not limited to, such things as:
 - (a) The temporary or permanent loss of the dexterity necessary to operate the CS to safely control the small RPA.
 - (b) The inability to maintain the required “see and avoid” vigilance due to blurred vision.
 - (c) The inability to maintain proper situational awareness of the small RPA operations due to illness and/or medication(s), such as after taking medications with cautions not to drive or operate heavy machinery.

- (d) A debilitating physical condition, such as a migraine headache or moderate or severe body ache(s) or pain(s) that would render the remote PIC, person manipulating the controls, or VO unable to perform RPAs operational duties.
 - (e) A hearing or speaking impairment that would inhibit the remote PIC, person manipulating the controls, and VO from effectively communicating with each other. In a situation such as this, the remote PIC must ensure that an alternative means of effective communication is implemented. For example, a person who is hearing impaired may be able to effectively use sign language to communicate.
3. Part 101 does not allow operation of an RPAs if the remote PIC, person manipulating the controls, or VO is unable to safely carry out his or her responsibilities. It is the remote PIC's responsibility to ensure all crewmembers are not participating in the operation while impaired. While drug and alcohol use are known to impair judgment, certain over-the-counter medications and medical conditions could also affect the ability to safely operate a small RPA. For example, certain antihistamines and decongestants may cause drowsiness. We also emphasise that Part 101 prohibits a person from serving as a remote PIC, person manipulating the controls, VO, or other crewmember if he or she:
- (a) Consumed any alcoholic beverage within the preceding 8 hours;
 - (b) Is under the influence of alcohol;
 - (c) Has a blood alcohol concentration of more than more than 0,02 g per 100 ml; and/or
 - (d) Is using a drug that affects the person's mental or physical capabilities.
4. Certain medical conditions, such as epilepsy, may also create a risk to operations. It is the remote PIC's responsibility to determine that their medical condition is under control and they can safely conduct a RPAS operation.

101.02.5

REMOTE PILOT IN COMMAND

1. Aircraft Operation. Just like a manned-aircraft PIC, the remote PIC of an RPAs is directly responsible for, and is the final authority as to, the operation of that RPAS. The remote PIC will have final authority over the flight. Additionally, a person manipulating the controls can participate in flight operations under certain conditions. It is important to note that a person may not operate or act as a remote PIC or VO in the operation of more than one RPA at the same time. The following items describe the requirements for both a remote PIC and a person manipulating the controls:
- (a) Remote PIC. A person acting as a remote PIC of an under Part 101 must obtain a remote pilot licence with an RPAs rating issued by the Executive Director prior to RPAs operation. The remote PIC must have this licence easily accessible during flight operations. Requirements regarding remote pilot certification are published in Part 101 Subpart C, Remote Pilot Certification. Again, the remote PIC will have the final authority and responsibility for the operation and safety of an RPAs operation conducted under Part 101.

Additionally, Part 101 permits transfer of control of an RPAs between licenced remote pilots. Two or more licenced remote pilots transferring operational control (i.e., the remote PIC designation) to each other may do so only if they are both capable of maintaining Visual Line of Sight (VLOS) of the RPA and without loss of control (LOC). For example, one remote pilot may be designated the remote PIC at the beginning of the operation, and

then at some point in the operation another remote pilot may take over as remote PIC by positively communicating that he or she is doing so. As the person responsible for the safe operation of the RPAS, any remote pilot who will assume remote PIC duties should meet all of the requirements of Part 101, including awareness of factors that could affect the flight.

- (b) **Person Manipulating the Flight Controls.** A person who does not hold a remote pilot licence or a remote pilot that has not met the recurrent testing requirements of Part 101 may operate the RPAs under Part 101, as long as he or she is directly supervised by a remote PIC and the remote PIC has the ability to immediately take direct control of the sRPAS. This ability is necessary to ensure that the remote PIC can quickly address any hazardous situation before an accident occurs. The ability for the remote PIC to immediately take over the flight controls could be achieved by using a number of different methods. For example, the operation could involve a “buddy box” type system that uses two control stations (CS): one for the person manipulating the flight controls and one for the remote PIC that allows the remote PIC to override the other CS and immediately take direct control of the small RPA. Another method could involve the remote PIC standing close enough to the person manipulating the flight controls so as to be able to physically take over the CS from the other person. A third method could employ the use of an automation system whereby the remote PIC could immediately engage that system to put the small RPA in a pre-programmed “safe” mode (such as in a hover, in a holding pattern, or “return home”).
- (c) **Autonomous Operations.** An autonomous operation is generally considered an operation in which the remote pilot inputs a flight plan into the CS, which sends it to the autopilot on-board the small RPA. During automated flight, flight control inputs are made by components on-board the aircraft, not from a CS. Thus, the remote PIC could lose the control link to the small RPA and the aircraft would still continue to fly the programmed mission/return home to land. During automated flight, the remote PIC also must have the ability to change routing/altitude or command the aircraft to land immediately. The ability to direct the small RPA may be through manual manipulation of the flight controls or through commands using automation.

The remote PIC must retain the ability to direct the small RPA to ensure compliance with the requirements of Part 101. There are a number of different methods that a remote PIC may utilise to direct the small RPA to ensure compliance with Part 101. For example, the remote pilot may transmit a command for the autonomous aircraft to climb, descend, land now, proceed to a new waypoint, enter an orbit pattern, or return to home. Any of these methods may be used to satisfactorily avoid a hazard or give right of way.

The use of automation does not allow a person to simultaneously operate more than one small RPA.

- (d) **Crew Resource Management (CRM).** Effective CRM is an essential component of safe RPAS operations. It requires the pilot to make effective use of all available resources: human resources, hardware, and information. Many remote pilots operating under Part 101 may use a VO, oversee other persons manipulating the controls of the small RPA, or any other person who the remote PIC may interact with to ensure safe operations. Therefore, a remote PIC must be able to function in a team environment and maximize team performance. This skill set includes decision making, situational awareness, proper allocation of tasks to individuals, avoidance of work overload in self and in others, and effectively communicating with other members of the crew, such as VOs and persons manipulating the controls of an sRPAS. Appendix 1, Risk Assessment Tools, contains expanded information on CRM, as well as sample risk assessment tools to aid in identifying hazards and mitigating risks.

101.02.6

IN-FLIGHT EMERGENCY

1. An in-flight emergency is an unexpected and unforeseen serious occurrence or situation that requires urgent, prompt action. In case of an in-flight emergency, the remote PIC is permitted to deviate from any rule of Part 101 to the extent necessary to respond to that emergency. A remote PIC who exercises this emergency power to deviate from the rules of Part 101 is required to send a written report to the Executive Director explaining the deviation. Emergency action should be taken in such a way as to minimize injury or damage to property.

101.02.7

HAZARDOUS OPERATION

1. As with manned aircraft, remote PICs are prohibited from engaging in a careless or reckless operation. Remote pilots should note that because RPAs have additional operating considerations that are not present in manned aircraft operations, there may be additional activity that would be careless or reckless if conducted using an sRPAS. For example, failure to consider weather conditions near structures, trees, or rolling terrain when operating in a densely populated area could be determined as careless or reckless operation.

101.02.10

DAYLIGHT OPERATION

1. Civil Twilight Operations. When RPAs operations are conducted during civil twilight, the small RPA must be equipped with anticollision lights that are capable of being visible for at least 5 km (3 sm). However, the remote PIC may reduce the visible distance of the lighting less than 5 km (3 sm) during a given flight if he or she has determined that it would be in the interest of safety to do so, for example if it impacts his or her night vision. RPAs not operated during civil twilight are not required to be equipped with anti-collision lighting.

101.02.11

VISUAL LINE OF SIGHT AIRCRAFT OPERATION

1. VLOS. The remote PIC and person manipulating the controls must be able to see the small RPA at all times during flight. Therefore, the small RPA must be operated closely enough to the CS to ensure visibility requirements are met during small RPA operations. This requirement also applies to the VO, if used during the aircraft operation. However, the person maintaining VLOS may have brief moments in which he or she is not looking directly at or cannot see the small RPA, but still retains the capability to see the RPA or quickly manoeuvre it back to VLOS. These moments can be for the safety of the operation (e.g., looking at the controller to see battery life remaining) or for operational necessity.

For operational necessity, the remote PIC or person manipulating the controls may intentionally manoeuvre the RPA so that he or she loses sight of it for brief periods of time. Should the remote PIC or person manipulating the controls lose VLOS of the small RPA, he or she must regain VLOS as soon as practicable. For example, a remote PIC stationed on the ground utilising a small RPA to inspect a rooftop may lose sight of the aircraft for brief periods while inspecting the farthest point of the roof. As another example, a remote PIC conducting a search operation around a fire scene with a small RPA may briefly lose sight of the aircraft while it is temporarily behind a dense column of smoke. However, it must be emphasised that even

though the remote PIC may briefly lose sight of the small RPA, he or she always has the see-and-avoid responsibilities set out in Part 101.

The circumstances of what would prevent a remote PIC from fulfilling those responsibilities will vary, depending on factors such as the type of RPAS, the operational environment, and distance between the remote PIC and the RPA. For this reason, there is no specific time interval that interruption of VLOS is permissible, as it would have the effect of potentially allowing a hazardous interruption or prohibiting a reasonable one. If VLOS cannot be regained, the remote PIC or person manipulating the controls should follow pre-determined procedures for a loss of VLOS. These procedures are determined by the capabilities of the RPAs and may include immediately landing the RPA, entering hover mode, or returning to home sequence. Thus, the VLOS requirement would not prohibit actions such as scanning the airspace or briefly looking down at the CS.

2. Unaided Vision. VLOS must be accomplished and maintained by unaided vision, except vision that is corrected by the use of spectacles or contact lenses. Vision aids, such as binoculars, may be used only momentarily to enhance situational awareness. For example, the remote PIC, person manipulating the controls, or VO may use vision aids to avoid flying over persons or conflicting with other aircraft. Similarly, first person view devices may be used during operations, but note that such devices do not satisfy the VLOS requirement. While the rule does not set specific vision standards, the CAA recommends that remote PICs, persons manipulating the controls, and VOs maintain 20/20 distant vision acuity (corrected) and normal field of vision.

101.02.12

VISUAL OBSERVER

1. The use of a VO is optional. The remote PIC may choose to use a VO to supplement situational awareness and VLOS. Although the remote PIC and person manipulating the controls must maintain the capability to see the RPA, using one or more VOs allows the remote PIC and person manipulating the controls to conduct other mission-critical duties (such as checking displays) while still ensuring situational awareness of the RPA. The VO must be able to effectively communicate:
 - (a) The small RPA location, attitude, altitude, and direction of flight;
 - (b) The position of other aircraft or hazards in the airspace; and
 - (c) The determination that the RPA does not endanger the life or property of another.
2. To ensure that the VO can carry out his or her duties, the remote PIC must ensure that the VO is positioned in a location where he or she is able to see the small RPA sufficiently to maintain VLOS. The remote PIC can do this by specifying the location of the VO. It is also required that the remote PIC and VO coordinate to 1) scan the airspace where the small RPA is operating for any potential collision hazard, and 2) maintain awareness of the position of the small RPA through direct visual observation. This would be accomplished by the VO maintaining visual contact with the small RPA and the surrounding airspace, and then communicating to the remote PIC and person manipulating the controls the flight status of the small RPA and any hazards which may enter the area of operation, so that the remote PIC or person manipulating the controls can take appropriate action.

To make this communication possible, the remote PIC, person manipulating the controls, and VO must work out a method of effective communication, which does not create a distraction and allows them to understand each other. The communication method must be determined

prior to operation. This effective communication requirement would permit the use of communication-assisting devices, such as a hand-held radio, to facilitate communication from a distance.

101.02.15

OPERATION NEAR AIRCRAFT AND RIGHT-OF-WAY RULES

1. A remote PIC has a responsibility to operate the small RPA so it remains clear of and gives way to all other aircraft. This is traditionally referred to as “see and avoid.” To satisfy this responsibility, the remote PIC must know the location and flight path of his or her small RPA at all times. The remote PIC must be aware of other aircraft, persons, and property in the vicinity of the operating area, and manoeuvre the small RPA to avoid a collision, as well as prevent other aircraft from having to take action to avoid the small RPA.

101.02.16

OPERATION OVER HUMAN BEINGS

1. Part 101 prohibits a person from flying a small RPA directly over a person who is not under a safe cover, such as a protective structure or a stationary vehicle. However, a small RPA may be flown over a person who is directly participating in the operation of the sRPAS, such as the remote PIC, other person manipulating the controls, a VO, or crewmembers necessary for the safety of the RPAs operation, as assigned and briefed by the remote PIC. There are several ways that the RPAs remote PIC can comply with these requirements, such as:
 - (a) Selecting an operational area (site) that is clearly unpopulated/uninhabited. If selecting a site that is populated/inhabited, have a plan of action which ensures persons remain clear of the operating area, remain indoors, or remain under safe cover until such time that the small RPA flight has ended. Safe cover is a structure or stationary vehicle that would protect a person from harm if the small RPA were to crash into that structure or vehicle;
 - (b) Establishing an operational area in which the remote PIC has taken reasonable precautions to keep free of persons not directly participating in the operation of the sRPAS;
 - (c) Choosing an operating area that is sparsely populated, or, ideally, clear of persons if operating a small RPA from a moving vehicle;
 - (d) Having a plan of action that ensures the small RPA remains clear of persons who may enter the operating area.
 - (e) Adopt an appropriate operating distance from persons not directly participating in the operation of the sRPAS.

101.02.18, 101.02.19, 101.02.120

OPERATION IN CERTAIN AIRSPACE, OPERATION IN THE VICINITY OF AIRPORTS AND OPERATION IN PROHIBITED OR RESTRICTED AREAS

1. Though many RPAs operations will occur in uncontrolled airspace, there are some that may need to operate in controlled airspace. Operations in Class A, Class B, Class C, or Class D airspace, or within the lateral boundaries of the surface area of Class E airspace designated for an aerodrome, are not allowed unless that person has prior authorisation from air traffic control (ATC). The RPAs remote PIC must understand airspace classifications and requirements.

Failure to do so would be in violation of the Part 101 regulations and may potentially have an adverse safety effect. Although RPAs will not be subject to Part 91, the equipment and communications requirements outlined in Part 91 were designed to provide safety and efficiency in controlled airspace. Accordingly, while RPAs operating under Part 101 are not subject to Part 91, as a practical matter, ATC authorisation or clearance may depend on operational parameters similar to those found in Part 91. The Executive Director has the authority to approve or deny aircraft operations based on traffic density, controller workload, communication issues, or any other type of operations that could potentially impact the safe and expeditious flow of air traffic in that airspace. Those planning RPAs operations in controlled airspace are encouraged to contact the Executive Director and the applicable ATSU as early as possible.

2. 101.02.18 specifies the requirements for operation in the vicinity of aerodromes and heliports. When operating in the vicinity of an aerodrome, the remote PIC must be aware of all traffic patterns and approach corridors to runways and landing areas. The remote PIC must avoid operating anywhere that the presence of the RPAs may interfere with operations at the aerodrome or heliport, such as approach corridors, taxiways, runways, or helipads. Furthermore, the remote PIC must give way to all other aircraft, including aircraft operating on the surface of the aerodrome.
3. Remote PICs are prohibited from operating their small RPA in a manner that interferes with operations and traffic patterns at aerodromes, heliports, and seaplane bases. While a small RPA must always yield right-of-way to a manned aircraft, a manned aircraft may alter its flightpath, delay its landing, or take off in order to avoid an RPAs that may present a potential conflict or otherwise affect the safe outcome of the flight. For example, a RPA hovering 200 feet above a runway may cause a manned aircraft holding short of the runway to delay take-off, or a manned aircraft on the downwind leg of the pattern to delay landing. While the RPA in this scenario would not pose an immediate traffic conflict to the aircraft on the downwind leg of the traffic pattern or to the aircraft intending to take off, nor would it violate the right-of-way provision of 101.02.14, the small RPA would have interfered with the operations of the traffic pattern at an aerodrome.
4. In order to avoid interfering with operations in a traffic pattern, remote PICs should avoid operating in the traffic pattern or published approach corridors used by manned aircraft. When operational necessity requires the remote PIC to operate at an aerodrome in uncontrolled airspace, the remote PIC should operate the small RPA in such a way that the manned aircraft pilot does not need to alter his or her flightpath in the traffic pattern or on a published instrument approach in order to avoid a potential collision. Because remote PICs have an obligation to give way to all other aircraft and avoid interfering in traffic pattern operations, the Executive Director expects that most remote PICs will avoid operating in the vicinity of aerodromes because their aircraft generally do not require aerodrome infrastructure, and the concentration of other aircraft increases in the vicinity of aerodromes.
5. **Recurring or Long-Term Operations.** For recurring or long-term operations in a given volume of controlled airspace, ATSUs may consider issue of prior authorisation in the form of a letter of agreement (LOA). This LOA will outline the ability to integrate into the existing air traffic operation and may improve the likelihood of access to the airspace where operations are proposed. This agreement will ensure all parties involved are aware of limitations and conditions and will enable the safe flow of aircraft operations in that airspace. For short-term or short-notice operations proposed in controlled aerodrome airspace, prior authorisation is required.
6. **Temporary Flight Restrictions.** Certain temporary flight restrictions may be imposed by way of a NOTAM. Therefore, it is necessary for the RPAs remote PIC to check for NOTAMs before each flight to determine if there are any applicable airspace restrictions.

7. Type of Airspace. It is important that RPAs remote PICs be aware of the type of airspace in which they will be operating their small RPA. They should refer to a current aeronautical chart of the intended operating area when planning operations in Namibian airspace.

101.02.21

PRE-FLIGHT FAMILIARISATION, INSPECTION, AND ACTIONS FOR AIRCRAFT OPERATION

1. The remote PIC shall complete a pre-flight familiarisation, inspection, and other actions, such as crewmember briefings, prior to beginning flight operations. All applicable publications providing information on topics such as aviation weather, aircraft loading and performance, emergency procedures, CRM, and airspace, should be considered prior to operations.
2. Prior to Flight. The remote PIC must:
 - (a) Conduct an assessment of the operating environment. The assessment must include at least the following:
 - Local weather conditions,
 - Local airspace and any flight restrictions,
 - The location of persons and property on the surface, and
 - Other ground hazards.
 - (b) Ensure that all persons directly participating in the small RPA operation are informed about the following:
 - Operating conditions,
 - Emergency procedures,
 - Contingency procedures,
 - Roles and responsibilities of each person involved in the operation, and
 - Potential hazards.
 - (c) Ensure that all control links between the CS and the small RPA are working properly. For example, before each flight, the remote PIC must determine that the small RPA flight control surfaces necessary for the safety of flight are moving correctly through the manipulation of the small RPA CS. If the remote PIC observes that one or more of the control surfaces are not responding correctly to CS inputs, then the remote PIC may not conduct flight operations until correct movement of all flight control surface(s) is established.
 - (d) Ensure there is sufficient power to continue controlled flight operations to a normal landing. One of the ways that this could be done is by following the RPAs manufacturer's operating manual power consumption tables. Another method would be to include a system on the RPAs that detects power levels and alerts the remote pilot when remaining aircraft power is diminishing to a level that is inadequate for continued flight operation.

- (e) Ensure that any object attached or carried by the small RPA is secure and does not adversely affect the flight characteristics or controllability of the aircraft.
 - (f) Ensure that all necessary documentation is available for inspection, including the remote PIC's remote pilot licence and, where applicable, any exemption issued by the Executive Director .
3. Safety Risk Assessment. These pre-flight familiarisations, inspections, and actions can be accomplished as part of an overall safety risk assessment. The Executive Director encourages the remote PIC to conduct the overall safety risk assessment as a method of compliance with the prohibition on operations over certain persons and the requirement to remain clear of other aircraft. Appendix 1 provides additional guidance on how to conduct an overall safety risk assessment.

101.02.22

OPERATING LIMITATIONS FOR SMALL REMOTELY PILOTED AIRCRAFT

1. The small RPA shall be operated in accordance with the following limitations:
- (a) Cannot be flown faster than a groundspeed of 87 knots (100 miles per hour);
 - (b) Cannot be flown higher than 400 feet above ground level (AGL), unless flown within a 120 m (400 ft) radius of a structure and does not fly higher than 400 feet above the structure's immediate uppermost limit;
 - (c) Minimum visibility, as observed from the location of the CS, may not be less than 5 km (3 sm); and
 - (d) Minimum distance from clouds being no less than 500 feet below a cloud and no less than 600 m (2000 ft) horizontally from the cloud.
- Note:* These operating limitations are intended, among other things, to support the remote pilot's ability to identify hazardous conditions relating to encroaching aircraft or persons on the ground, and to take the appropriate actions to maintain safety.
2. Determining Groundspeed. There are many different types of RPAs and different ways to determine groundspeed. Therefore, this guidance will only touch on some of the possible ways for the remote PIC to ensure that the small RPA does not exceed a groundspeed of 87 knots during flight operations. Some of the possible ways to ensure that 87 knots is not exceeded are as follows:
- (a) Installing a Global Positioning System (GPS) device on the small RPA that reports groundspeed information to the remote pilot, wherein the remote pilot takes into account the wind direction and speed and calculates the small RPA airspeed for a given direction of flight, or
 - (b) Timing the groundspeed of the small RPA when it is flown between two or more fixed points, taking into account wind speed and direction between each point, then noting the power settings of the small RPA to operate at or less than 87 knots groundspeed, or
 - (c) Using the small RPA's manufacturer design limitations (e.g., installed groundspeed limiters).

3. Determining Altitude. In order to comply with the maximum altitude requirements of Part 101, as with determining groundspeed, there are multiple ways to determine a small RPA's altitude above the ground or structure. Some possible ways for a remote pilot to determine altitude are as follows:
 - (a) Installing a calibrated altitude reporting device on the small RPA that reports the small RPA altitude above mean sea level (MSL) to the remote pilot, wherein the remote pilot subtracts the MSL elevation of the CS from the small RPA reported MSL altitude to determine the small RPA AGL altitude above the terrain or structure;
 - (b) Installing a GPS device on the small RPA that also has the capability of reporting MSL altitude to the remote pilot;
 - (c) With the small RPA on the ground, have the remote pilot and VO pace off 400 feet from the small RPA to get a visual perspective of the small RPA at that distance, wherein the remote pilot and VO maintain that visual perspective or closer while the small RPA is in flight; or
 - (d) Using the known height of local rising terrain and/or structures as a reference.
4. Visibility and Distance from Clouds. Once the remote PIC and VO have been able to reliably establish the small RPA height above ground level, it is incumbent on the remote PIC to determine that visibility from the CS is at least 5 km (3 sm) and that the small RPA is kept at least 500 feet below a cloud and at least 600 m (2,000 ft) horizontally from a cloud. One of the ways to ensure adherence to the minimum visibility and cloud clearance requirements is to obtain local aviation weather reports that include current and forecast weather conditions. If there is more than one local aviation reporting station near the operating area, the remote PIC should choose the closest one that is also the most representative of the terrain surrounding the operating area. If local aviation weather reports are not available, then the remote PIC may not operate the small RPA if he or she is not able to determine the required visibility and cloud clearances by other reliable means. It is imperative that the RPA not be operated above any cloud, and that there are no obstructions to visibility, such as smoke or a cloud, between the RPA and the remote PIC.

Note: Remote pilots should additionally take account of the supplementary operational information given in Appendix 2.

APPENDIX 1

RISK ASSESSMENT TOOLS

1. The information in this Appendix is a presentation of aeronautical decision-making (ADM), Crew Resource Management (CRM), and an example of a viable risk assessment process. This process is used to identify hazards and classify the potential risk that those hazards could present in an operation. It also provides examples of potential criteria for the severity of consequences and likelihood of occurrence that may be used by an RPAs remote pilot in command (PIC).
2. Aeronautical Decision-Making (ADM). The ADM process addresses all aspects of decision-making in a solo or crew environment and identifies the steps involved in good decision-making. These steps for good decision-making are as follows:
 - (a) Identifying Personal Attitudes Hazardous to Safe Flight. Hazardous attitudes can affect unmanned operations if the remote PIC is not aware of the hazards, leading to such things as: getting behind the aircraft/situation, operating without adequate fuel/battery reserve, loss of positional or situational awareness, operating outside the envelope, and failure to complete all flight planning tasks, pre-flight inspections, and checklists. Operational pressure can contribute to these pit-falls.
 - (b) Learning Behaviour Modification Techniques. Continuing to utilise risk assessment procedures for the operation will assist in identifying risk associated with the operation. Conducting an attitude assessment will identify situations where a hazardous attitude may be present.
 - (c) Learning How to Recognize and Cope with Stress. Stress is ever present in our lives and you may already be familiar with situations that create stress in aviation. However, RPAS operations may create stressors that differ from manned aviation. Such examples may include: working with an inexperienced crewmember, lack of standard crewmember training, interacting with the public and officials, and understanding regulatory requirements. Proper planning for the operation can reduce or eliminate stress, allowing you to focus more clearly on the operation.
 - (d) Developing Risk Assessment Skills. As with any aviation operation, identifying associated hazards is the first step. Analysing the likelihood and severity of the hazards occurring establishes the probability of risk. In most cases, steps can be taken to mitigate, even eliminate, those risks. Actions such as using visual observers (VO), completing a thorough pre-flight inspection, planning for weather, familiarity with the airspace, proper aircraft loading, and performance planning can mitigate identified risks. Figure 1, Hazard Identification and Risk Assessment Process Chart, is an example of a risk assessment tool. Others are also available for use.
 - (e) Using All Available Resources with More Than One Crewmember (CRM). A characteristic of CRM is creating an environment where open communication is encouraged and expected, and involves the entire crew to maximize team performance. Many of the same resources that are available to manned aircraft operations are available to RPAS operations. For example, remote PICs can take advantage of traditional CRM techniques by utilising additional crewmembers, such as VOs and other ground crew. These crewmembers can provide information about traffic, airspace, weather, equipment, and aircraft loading and performance. Examples of good CRM include:
 - iv) Communication Procedures. One way to accomplish this is to have the VO maintain visual contact with the small RPA and maintain awareness of the

surrounding airspace, and then communicate flight status and any hazards to the remote PIC and person manipulating the controls so that appropriate action can be taken. Then, as conditions change, the remote PIC should brief the crew on the changes and any needed adjustments to ensure a safe outcome of the operation.

- v) **Communication Methods.** The remote PIC, person manipulating the controls, and VO must work out a method of communication, such as the use of a hand-held radio or other effective means, that would not create a distraction and allows them to understand each other. The remote PIC should evaluate which method is most appropriate for the operation prior to flight.
- vi) **Task Management.** Tasks vary depending on the complexity of the operation. Depending upon the area of the operations, additional crewmembers may be needed to safely operate. Enough crewmembers should be utilised to ensure no one on the team becomes overloaded. Once a member of the team becomes overworked, there's a greater possibility of an incident/accident.
- vii) **Other Resources.** Take advantage of information from a weather briefing, air traffic control (ATC), the CAA, local pilots, and landowners. Technology can aid in decision-making and improve situational awareness. Being able to collect the information from these resources and manage the information is key to situational awareness and could have a positive effect on your decision-making.

(f) **Evaluating the Effectiveness of One's Decision-Making Skills.** Successful decision-making is measured by a pilot's consistent ability to keep himself or herself, any persons involved in the operation, and the aircraft in good condition regardless of the conditions of any given flight. As with manned operations, complacency and overconfidence can be risks, and so there are several checklists and models to assist in the decision-making process.

3. **Hazard Identification.** Hazards in the RPAs and its operating environment must be identified, documented, and controlled. The analysis process used to define hazards needs to consider all components of the system, based on the equipment being used and the environment it is being operated in. The key question to ask during analysis of the RPAs and its operation is "*what if?*" Remote PICs are expected to exercise due diligence in identifying significant and reasonably foreseeable hazards related to their operations.
4. **Risk Analysis and Assessment.** The risk assessment should use a conventional breakdown of risk by its two components: likelihood of occurrence and severity.
5. **Severity and Likelihood Criteria.** There are several tools which can be utilised in determining severity and likelihood when evaluating a hazard. One tool is a risk matrix. Several examples of these are presented in Figure 2, Safety Risk Matrix Examples. The definitions and construction of the matrix is left to the RPAs remote PIC to design. The definitions of each level of severity and likelihood need to be defined in terms that are realistic for the operational environment. This ensures each remote PIC's decision tools are relevant to their operations and operational environment, recognizing the extensive diversity which exists. An example of severity and likelihood definitions is shown in Table 1, Sample Severity and Likelihood Criteria.

Figure 1. Hazard Identification and Risk Assessment Process Chart

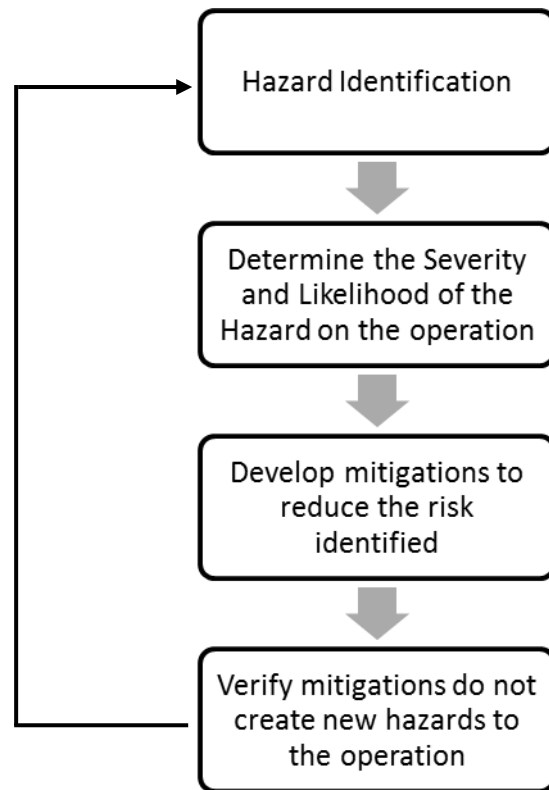


Table 1. Sample Severity and Likelihood Criteria

Severity of Consequences			Likelihood of Occurrence		
Severity Level	Definition	Value	Likelihood Level	Definition	Value
Catastrophic	Equipment destroyed, multiple deaths.	5	Frequent	Likely to occur many times	5
Hazardous	Large reduction in safety margins, physical distress, or a workload such that crewmembers cannot be relied upon to perform their tasks accurately or completely. Serious injury or death. Major equipment damage.	4	Occasional	Likely to occur sometimes	4
Major	Significant reduction in safety margins, reduction in the ability of crewmembers to cope with adverse operating conditions as a result of an increase in workload, or as result of conditions impairing their efficiency. Serious incident. Injury to persons.	3	Remote	Unlikely, but possible to occur	3
Minor	Nuisance. Operating limitations. Use of emergency procedures. Minor incident.	2	Improbable	Very unlikely to occur	2
Negligible	Little consequence.	1	Extremely Improbable	Almost inconceivable that the event will occur	1

6. Risk Acceptance. In the development of risk assessment criteria, RPAs remote PICs are expected to develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management decision-making. The acceptability of risk can be evaluated using a risk matrix, such as those illustrated in Figure 2, which shows three areas of acceptability. Risk matrices may be colour coded; unacceptable (red), acceptable (green), and acceptable with mitigation (yellow).

(a) Unacceptable (Red). Where combinations of severity and likelihood cause risk to fall into the red area, the risk would be assessed as unacceptable and further work would be required to design an intervention to eliminate that associated hazard or to control the factors that lead to higher risk likelihood or severity.

(b) Acceptable (Green). Where the assessed risk falls into the green area, it may be accepted without further action. The objective in risk management should always be to reduce risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is.

(c) Acceptable with Mitigation (Yellow). Where the risk assessment falls into the yellow area, the risk may be accepted under defined conditions of mitigation. An example of this situation would be an assessment of the impact of an RPAs operation near a school. Scheduling the operation to take place when the school is not in session could be one mitigation to prevent undue risk to the children that study and play there. Another mitigation could be restricting people from the area of operations by placing cones or security personnel to prevent unauthorised access during the RPAs flight operation.

Figure 2. Safety Risk Matrix Examples

Example 1

Severity Likelihood			Higher Lower		
↑				Unacceptable	
More Less		Acceptable with Mitigation			
↓	Acceptable				

Example 2.

Risk Likelihood		Risk Severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely Improbable	1	1A	1B	1C	1D	1E

7. Other Risk Assessment Tools for Flight and Operational Risk Management. Other tools can also be used for flight or operational risk assessments and can be developed by the remote PICs themselves. The key thing is to ensure that all potential hazards and risks are identified and appropriate actions are taken to reduce the risk to persons and property not associated with the operations.
8. Reducing Risk. Risk analyses should concentrate not only on assigning levels of severity and likelihood, but on determining why these particular levels were selected. This is referred to as root cause analysis, and is the first step in developing effective controls to reduce risk to lower levels. In many cases, simple brainstorming sessions among crewmembers is the most effective and affordable method of finding ways to reduce risk. This also has the advantage of involving people who will ultimately be required to implement the controls developed.

It is also very easy to get quite bogged down in trying to identify all hazards and risks. That is not the purpose of a risk assessment. The focus should be upon those hazards which pose the greatest risks. As stated earlier, by documenting and compiling these processes, a remote PIC can build an arsenal of safety practices that will add to the safety and success of future operations.

9. Sample Hazard Identification and Risk Assessment.

I am the remote PIC of an RPAs in the proximity of an accident scene shooting aerial footage. Much like pilots in manned aircraft I must adhere to pre-flight action (Part 91), I must adhere to pre-flight familiarisation, inspection, and aircraft operations. Let's say that there is an obvious take-off and landing site that I intend to use. What if, while I am operating my sRPA, an air ambulance helicopter requires use of the same area and I am not left with a suitable landing site? Furthermore, I am running low on power. If I consider this situation prior to flight, I can use a basic hazard identification and mitigation process. Through this process, I might determine that an acceptable level of risk can be achieved by also having an alternate landing site and possibly additional sites at which I can sacrifice the RPA to avoid imposing risk to people on the ground or to manned aircraft operations. It is really a simple process: I must

consider the hazards presented during this particular operation, determine the risk severity, and then develop a plan to lessen (or mitigate) the risk to an acceptable level. By documenting and compiling these processes, I can build an arsenal of safety practices that will add to the safety and success of future operations. The following are some proven methods that can help a new remote PIC along the way:

(a) Hazard Identification. Using the Personal Minimums (**P A V E**) Checklist for Risk Management, I will set personal minimums based upon my specific flight experience, health habits, and tolerance for stress, just to name a few. After identifying hazards, I will then input them into the Hazard Identification and Risk Management Process Chart (Figure 1).

viii) **Personal:** Am I healthy for flight and what are my personal minimums based upon my experience operating this sRPAS? During this step, I will often use the **I M S A F E** checklist in order to perform a more in-depth evaluation:

- **Illness** – Am I suffering from any illness or symptom of an illness which might affect me in flight?
- **Medication** – Am I currently taking any drugs (prescription or over-the-counter)?
- **Stress** – Am I experiencing any psychological or emotional factors which might affect my performance?
- **Alcohol** – Have I consumed alcohol within the last 8 to 24 hours?
- **Fatigue** – Have I received sufficient sleep and rest in the recent past?
- **Eating** – Am I sufficiently nourished?

ix) **Aircraft:** Have I conducted a pre-flight check of my RPAs (aircraft, control station (CS), take-off and landing equipment, etc.) and determined it to be in a condition for safe operation? Is the filming equipment properly secured to the aircraft prior to flight?

x) **EnVironment:** What is the weather like? Am I comfortable and experienced enough to fly in the forecast weather conditions? Have I considered all of my options and left myself an “out?” Have I determined alternative landing spots in case of an emergency?

xi) **External Pressures:** Am I stressed or anxious? Is this a flight that will cause me to be stressed or anxious? Is there pressure to complete the flight operation quickly? Am I dealing with an unhealthy safety culture? Am I being honest with myself and others about my personal operational abilities and limitations?

10. **Controlling Risk.** After hazards and risks are fully understood through the preceding steps, risk controls must be designed and implemented. These may be additional or changed procedures, additional or modified equipment, the addition of VOs, or any of a number of other changes.

11. **Residual and Substitute Risk.** Residual risk is the risk remaining after mitigation has been completed. Often, this is a multistep process, continuing until risk has been mitigated down to an acceptable level necessary to begin or continue operation. After these controls are designed but before the operation begins or continues, an assessment must be made of whether the controls are likely to be effective and/or if they introduce new hazards to the operation. The

latter condition, introduction of new hazards, is referred to as substitute risk, a situation where the cure is worse than the disease. The loop seen in Figure 1 that returns back to the top of the diagram depicts the use of the preceding hazard identification, risk analysis, and risk assessment processes to determine if the modified operation is acceptable.

12. Starting the Operation. Once appropriate risk controls are developed and implemented, then the operation can begin.

Appendix 2. Supplementary Operational Information

1. **Determining Operational Performance.** The manufacturer may provide operational and performance information that contains the operational performance data for the aircraft such as data pertaining to take-off, climb, range, endurance, descent, and landing. To be able to make practical use of the aircraft's capabilities and limitations, it is essential to understand the significance of the operational data. The use of this data in flying operations is essential for safe and efficient operation. It should be emphasised that the manufacturers' information regarding performance data is not standardised. If manufacturer-published performance data is unavailable, it is advisable to seek out performance data that may have already been determined and published by other users of the same RPAs manufacturer model and use that data as a starting point.

2. **RPAs Loading and Its Effects on Performance.**

- (a) **Mass and Balance (M&B).** Before any flight, the remote PIC should verify the aircraft is correctly loaded by determining the M&B condition of the aircraft. An aircraft's M&B restrictions established by the manufacturer or the builder should be closely followed. Compliance with the manufacturer's M&B limits is critical to flight safety. The remote PIC must consider the consequences of an over-weight aircraft if an emergency condition arises.

Although a maximum gross take-off mass may be specified, the aircraft may not always safely take off with this load under all conditions. Conditions that affect take-off and climb performance, such as high elevations, high air temperatures, and high humidity (high density altitudes) may require a reduction in mass before flight is attempted. Other factors to consider prior to take-off are runway/launch area length, surface, slope, surface wind, and the presence of obstacles. These factors may require a reduction in mass prior to flight.

Mass changes during flight also have a direct effect on aircraft performance. Fuel burn is the most common mass change that takes place during flight. As fuel is used, the aircraft becomes lighter and performance is improved, but this could have a negative effect on balance. In RPAS operations, mass change during flight may occur when expendable items are used on board (e.g., a jettisonable load).

- (b) **Balance, Stability, and Centre of Gravity (CG).** Adverse balance conditions (i.e., mass distribution) may affect flight characteristics in much the same manner as those mentioned for an excess mass condition. Limits for the location of the CG may be established by the manufacturer. The CG is not a fixed point marked on the aircraft; its location depends on the distribution of aircraft mass. As variable load items are shifted or expended, there may be a resultant shift in CG location. The remote PIC should determine how the CG will shift and the resultant effects on the aircraft. If the CG is not within the allowable limits after loading or do not remain within the allowable limits for safe flight, it will be necessary to relocate or shed some mass before flight is attempted.

3. **Sources of Weather Information for Small RPA Operations.** Remote PICs are encouraged to obtain weather information prior to flight. Aeronautical weather information including aerodrome reports and forecasts may be obtained from a number of free on-line sources.

4. **Weather and the Effects on Performance.** Weather is an important factor that influences aircraft performance and flying safety. Atmospheric pressure and density, wind, and uneven surface heating are factors that affect RPAs performance and must be considered prior to flight.

- (a) **Wind.** Wind speed and direction are important as they affect take-off, landing, and cruise of flight operations. Geological features, trees, structures, and other anomalies can affect the wind direction and speed close to the ground. In particular, ground topography, trees, and

buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed.

The remote PIC should be vigilant when operating RPAS near large buildings or other man-made structures and natural obstructions, such as mountains, bluffs, or canyons. The intensity of the turbulence associated with ground obstructions depends on the size of the obstacle and the primary velocity of the wind. This same condition is even more noticeable when flying in mountainous regions. While the wind flows smoothly up the windward side of the mountain and the upward currents help to carry an aircraft over the peak of the mountain, the wind on the leeward side does not act in a similar manner. As the air flows down the leeward side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of a mountain. The stronger the wind, the greater the downward pressure and turbulence become. Due to the effect terrain has on the wind in valleys or canyons, downdrafts can be severe.

- (b) **Surface Heat.** Different surfaces radiate heat in varying amounts. Ploughed ground, rocks, sand, and barren land give off a larger amount of heat, whereas water, trees, and other areas of vegetation tend to absorb and retain heat. The resulting uneven heating of the air creates small areas of local circulation called convective currents, which creates bumpy, turbulent air. Convective currents, with their rising and sinking air can adversely affect the controllability of the small RPA.
- 5. **Battery Fires.** Lithium-based batteries are highly flammable and capable of ignition. A battery fire could cause an in-flight emergency by causing loss of control of the RPA. Lithium battery fires can be caused when a battery short circuits, is improperly charged, is heated to extreme temperatures, is damaged as a result of a crash, is mishandled, or is simply defective. The remote PIC should consider following the manufacturer's recommendations, when available, to help ensure safe battery handling and usage.
- 6. **RPAs Frequency Utilization.** An RPAs typically uses radio frequencies (RF) for the communication link between the CS and the small RPA.
 - (a) **Frequency spectrum (RF) Basics.** The 2.4 GHz and 5.8 GHz systems are the unlicensed band RFs that most RPAs use for the connection between the CS and the small RPA. Note the frequencies are also used for computer wireless networks and the interference can cause problems when operating a RPA in an area (e.g., dense housing and office buildings) that has many wireless signals. Loss of control and flyaways are some of the reported problems with RPAs frequency implications.

To avoid frequency interference, many modern RPAs operate using a 5.8 GHz system to control the small RPA and a 2.4 GHz system to transmit video and photos to the ground. Consult the RPAs operating manual and manufacturers recommended procedures before conducting RPAs operations.

It should be noted that both RF bands (2.4 GHz and 5.8 GHz) are considered line of sight and the command and control link between the CS and the small RPA will not work properly when barriers are between the CS and the RPA. Part 101 requires the remote PIC or person manipulating the controls to be able to see the RPA at all times, which should also help prevent obstructions from interfering with the line of sight frequency spectrum.

- (b) **Spectrum Authorisation.** The frequency spectrum used for small RPA operations is regulated by the Communications Regulatory Authority of Namibia (CRAN). Radio transmissions, such as those used to control a RPA and to downlink real-time video, must use frequency bands that are approved for use by the regulating agency. In case of any doubt regarding allowable frequencies, remote pilots should consult CRAN.

Appendix 3. RPAs Maintenance and Inspection Best Practices

In the interest of assisting varying background levels of RPAs knowledge and skill, Table 2 lists conditions that, if noticed during a pre-flight inspection or check, may support a determination that the RPAS is not in a condition for safe operation. Further inspection to identify the scope of damage and extent of possible repair needed to remedy the unsafe condition may be necessary prior to flight.

Table 2. RPAs Condition Chart

Conditions that may be found may include, but are not limited to, the following:

Condition	Action
1. Structural or skin cracking	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
2. Delamination of bonded surfaces	Further inspect to determine scope of damage and existence of possible hidden damage that may compromise structural integrity. Assess the need and extent of repairs that may be needed for continued safe flight operations.
3. Liquid or gel leakage	Further inspect to determine source of the leakage. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
4. Strong fuel smell	Further inspect to determine source of the smell. Leakage exiting the aircraft may be present and/or accumulating within a sealed compartment. This condition may pose a risk of fire resulting in extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
5. Smell of electrical burning or arcing	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
6. Visual indications of electrical burning or arcing (black soot tracings, sparking)	Further inspect to determine source of the possible electrical malfunction. An electrical hazard may pose a risk of fire or extreme heat negatively impacting aircraft structures, aircraft

Condition	Action
	performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
7. Noticeable sound (decibel) change during operation by the propulsion system	Further inspect entire aircraft with emphasis on the propulsion system components (i.e., motors and propellers) for damage and/or diminished performance. Assess the need and extent of repairs that may be needed for continued safe flight operations.
8. Control inputs not synchronized or delayed	Discontinue flight and/or avoid further flight operations until further inspection and testing of the control link between the ground control unit and the aircraft. Ensure accurate control communications are established and reliable prior to further flight to circumvent possible loss of control resulting in the risk of a collision or flyaway. Assess the need and extent of repairs that may be needed for continued safe flight operations.
9. Battery casing distorted (bulging)	Further inspect to determine integrity of the battery as a reliable power source. Distorted battery casings may indicate impending failure resulting in abrupt power loss and/or explosion. An electrical hazard may be present, posing a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
10. Diminishing flight time capability (electric powered propulsion systems)	Further inspect to determine integrity of the battery as a reliable power source. Diminishing battery capacity may indicate impending failure due to exhausted service life, internal, or external damage. An electrical hazard may be present, posing a risk of fire or extreme heat negatively impacting aircraft structures, aircraft performance characteristics, and flight duration. Assess the need and extent of repairs that may be needed for continued safe flight operations.
11. Loose or missing hardware/fasteners	Further inspect to determine structural integrity of the aircraft and/or components with loose or missing hardware/fasteners. Loose or missing hardware/fasteners may pose a risk of negatively impacting flight characteristics, structural failure of the aircraft, dropped objects, loss of the aircraft, and risk to persons and property on the grounds. For continued safe flight operations, secure loose

Condition	Action
	hardware/fasteners. Replace loose hardware/fasteners that cannot be secured. Replace missing hardware/fasteners.