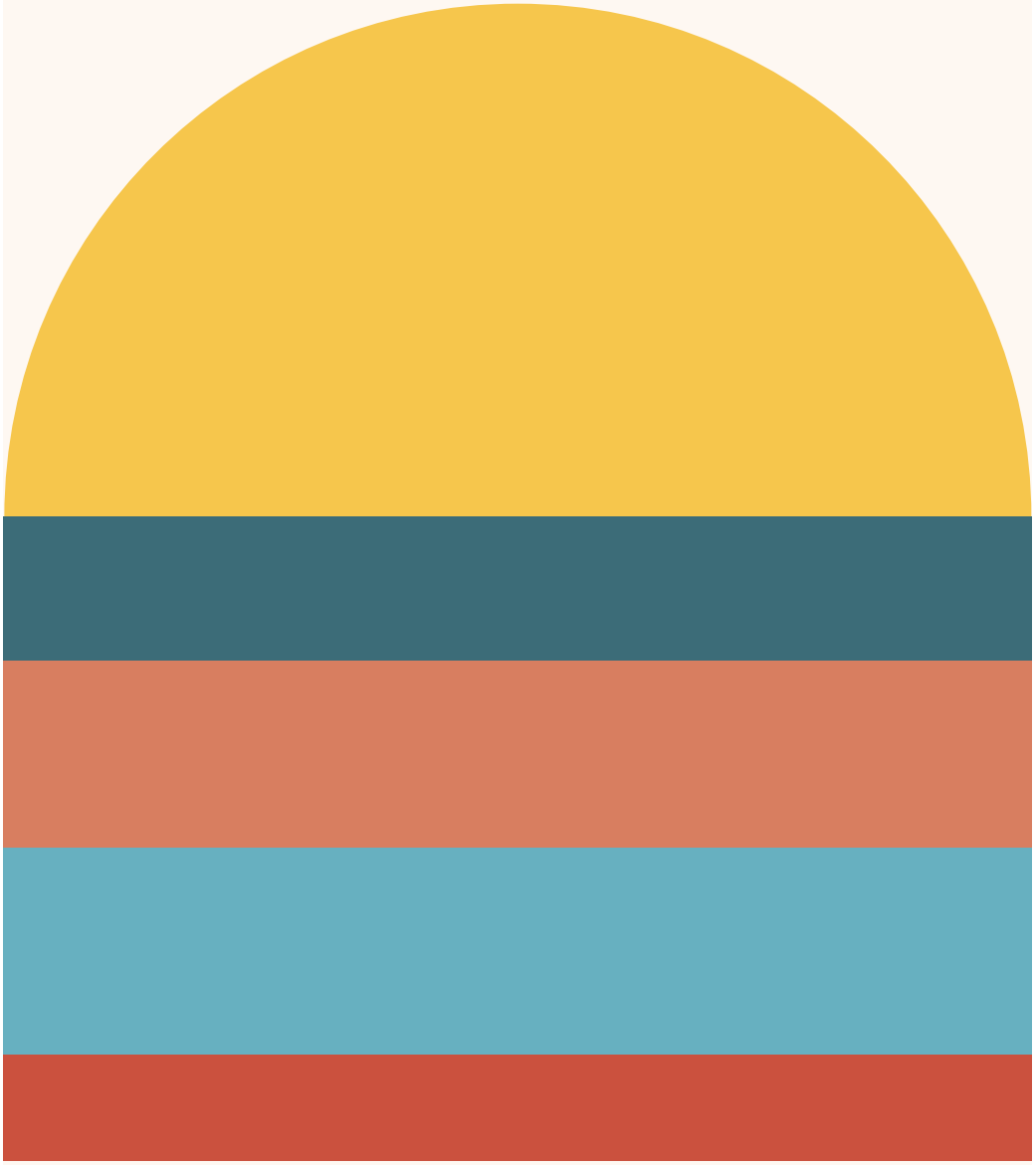
RPAS 101

A GENERAL KNOWLEDGE GUIDE FOR CANADIAN RPAS PILOTS



A JOINT PRODUCTION OF
TRANSPORT CANADA
AND
AERIAL EVOLUTION ASSOCIATION OF CANADA (AEAC)

BIG PICTURE

01

GET STARTED

- Achieve certification
- Register RPAS
- Become fully familiar with your RPAS
- Create SOPs & checklists

02

HOME/OFFICE PREP & PLANNING

- Determine a site
- Perform remote aspects of site survey
- Obtain NAV CANADA permission, as required
- Check weather and NOTAMs
- Prepare & pack equipment

03

PREPARING TO FLY

- Perform on-site survey & risk assessment
- Confirm weather and NOTAMs
- Unpack, inspect & prepare equipment
- Brief crew
- Respect NAV CANADA authorization conditions as required
- Fly safely!

04

POST-FLIGHT

- RespectNAV CANADA authorization conditions as required
- Log flight/incidents
- Inspect/pack
- Check data, as required
- Revise SOPs, as required, with lessons learned

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PREFACE

This guide has been developed in cooperation with Transport Canada (TC) and Aerial Evolution Association of Canada(AEAC) to provide a general knowledge guide to Canadian RPAS pilots. Think of this guide as an education booklet, similar to a driver's handbook, for new and inexperienced RPAS pilots and seasoned RPAS pilots. There is lot of information contained in this guide. Like much of aviation there is a lot more information available from other supporting sources.
Pilots are encouraged to learn as much as possible to help be a safe and contributing member of the RPAS community in Canada, and the world. Resources mentioned throughout this document are available toward the end.

Aviation safety begins with you, the pilot.

NOTE: The information in this publication is to be considered solely as a guide and should not be quoted as or considered to be a legal authority. It may become obsolete in whole or in part at any time without notice.

DEFINITIONS

AERODROME
Any area of land, water (including the frozen surface thereof) or other supporting surface used, designed, prepared, equipped or set apart for use, either in whole or in part, for the arrival, departure, movement or servicing of aircraft. This includes any buildings, installations and equipment situated thereon or associated therewith. *(AÉRODROME)*

AIRPORT (APRT)
An aerodrome for which an airport certificate is in force. An airport is denoted by the abbreviation “cert.” in the operator section of the Canada Flight Supplement (CFS). *(AÉROPORT)*

AIRSPACE AUTHORITY
Either NAV CANADA or the Department of National Defense who has command of and responsibility for the air navigation service in Canada. Depending on context, it can refer to the organization as a whole or the employees who are responsible for a particular area such as a control zone. May also be referred to as the Air Navigation Service Provider (ANSP). *(AUTORITÉ DE L’ESPACE AÉRIEN)*

AIRSPACE CLASSIFICATION
The division of the Canadian Domestic Airspace (CDA) into seven classes, each identified by a single letter: A, B, C, D, E, F or G. Airspace classifications determine the operating rules, the level of ATC service provided within the structure and, in some instances, communications and equipment requirements. The horizontal and vertical limits of airspace are described in the Designated Airspace Handbook (DAH). *(CLASSIFICATION DE L’ESPACE AÉRIEN)*

AIR TRAFFIC CONTROL SERVICE
A service provided for the purposes of
(a) preventing collisions between
  (i) aircraft;
  (ii)aircraft and obstacles; and
  (iii)aircraft and vehicles on the manoeuvring area and
(b) expediting and maintaining an orderly flow of air traffic.
Also called: ATC service *(SERVICES DE CONTRÔLE DE LA CIRCULATION AÉRIENNE)*

AIR TRAFFIC CONTROL UNIT (ATC)
As the circumstances require, this may be (a) an area control centre (ACC) established to provide ATC service to aircraft; or (b) an airport control tower unit established to provide ATC service to airport traffic. *(UNITÉDE CONTRÔLE DE LA CIRCULATION AÉRIENNE)*

AUTONOMOUS
In respect of a remotely piloted aircraft system, that the system is not designed to allow pilot intervention in the management of a flight. *(AUTONOME)*

BYSTANDER
An unofficial term used to explain the "people" referenced in prescriptive

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distance regulations for RPAS. Anyone who is unprotected by a roof (vehicle or building) and not considered part of the crew would be a bystander. Examples: pedestrians, cyclists and drivers of convertibles. Briefed personnel on a site may be considered a part of the operation and not bystanders (or people, as referenced in the CARs). *(PASSANT)*

BEYOND VISUAL LINE OF SIGHT (BVLOS)
Means a type of RPAS operation in which no crew member maintains unaided visual contact with the aircraft sufficient to be able to maintain control of the aircraft and know its location. *(OPÉRATIONS AU-DELÀ DE LAVISIBILITÉ DIRECTE)*

CANADA FLIGHT SUPPLEMENT (CFS)
The nation's official aerodrome directory. It contains information on all registered and certified Canadian aerodromes. It is expanded by the Water Aerodrome Supplement (WAS). *(SUPPLÉMENT DE VOL - CANADA)*

COMMAND AND CONTROL LINK
The data link between a remotely piloted aircraft and a control station that is used in the management of a flight. *(LIEN DE COMMANDE ET DE CONTRÔLE)*

COMMERCIAL OPERATIONS
Utilizing an RPAS in the basic or advanced operational environment for remuneration or hire. *(OPÉRATIONS COMMERCIALES)*

CONTROL STATION
The facilities or equipment that are remote from a remotely piloted aircraft and from which the aircraft is controlled and monitored. *(POSTE DE CONTRÔLE)*

CONTROLLED AIRSPACE
An airspace of defined dimensions within which Air Traffic Service (ATC) is provided. *(ESPACE AÉRIEN CONTRÔLÉ)*

CONTROL ZONE
A controlled airspace of defined dimensions extending upwards from the surface of the earth up to and including3 000 ft AAE unless otherwise specified. *(ZONE DE CONTRÔLE)*

CREW MEMBERS
The briefed roles maintained by a group of people operating an RPAS. Typical roles can include the pilot in command (PIC), visual observer(s) (VO), payload operator (PO) ground supervisor and sensor operator. *(MEMBRES D'ÉQUIPAGE)*

DAY
The period of time during any day that begins with the morning civil twilight and

ends with the evening civil twilight.
NOTE: Morning civil twilight begins in the morning when the centre of the sun's disc is 6° below the horizon. Evening civil twilight ends in the evening when the centre of the sun's disk dips 6° below the horizon. *(JOUR)*

DETECT AND AVOID FUNCTIONS
The capability to see, sense or detect conflicting air traffic or other hazards and take the appropriate action. *(FONCTIONS DÉTECTION ETÉVITEMENT)*

ESTABLISHED TRAFFIC PATTERN
Aircraft flying on the left side of the active runway making left hand turns in a rectangular pattern unless otherwise indicated in the PRO section of the CFS for an aerodrome. *(CIRCUIT D'AÉRODROMEÉTABLI)*

FIRST-PERSON VIEW DEVICE (FPV)
A device that generates and transmits a streaming video image to a control station display or monitor, giving the pilot of a remotely piloted aircraft the illusion of flying the aircraft from an on-board pilot's perspective. *(DISPOSITIF DE VUEÀLA PREMIÈRE PERSONNE)*

FLIGHT SERVICE STATION (FSS)
An Air Traffic Service (ATS) unit that provides services pertinent to the arrival and departure phases of flight at uncontrolled aerodromes and for transit through a mandatory frequency (MF) area. *(STATION D'INFORMATION DE VOL)*

FLIGHT TERMINATION SYSTEM
A system that, on activation, terminates the flight of a remotely piloted aircraft. *(SYSTÈME D'INTERRUPTION DE VOL)*

FLY-AWAY
In respect of a remotely piloted aircraft, an interruption or loss of the command and control link such that the pilot is no longer able to control the aircraft and the aircraft no longer follows its preprogrammed procedures or operates in a predictable or planned manner. *(DÉRIVE)*

IN HG
Abbreviation for "inches of mercury" which is a unit of atmospheric pressure. *(IN HG)*

MANDATORY ACTION
The inspection, repair or modification of a remotely piloted aircraft system that the manufacturer of the system considers necessary to prevent an unsafe or potentially unsafe condition. *(MESURE OBLIGATOIRE)*

MANDATORY FREQUENCY (MF)
A very high frequency (VHF) specified in the Canada Air Pilot (CAP), the Canada Flight Supplement (CFS) or the Canada Water Aerodrome Supplement (CWAS) for the use of radio-equipped aircraft operating within a mandatory frequency (MF) area. *(FRÉQUENCE OBLIGATOIRE)*

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NIGHT
The period of time during any day that starts at the end of evening civil twilight and ends at the start of morning civil twilight. *(NUIT)*

Note: Morning civil twilight begins in the morning when the centre of the sun's disc is 6° below the horizon. Evening civil twilight ends in the evening when the centre of the sun's disk dips 6° below the horizon.

NOTAM (NOTICE TO AIRMEN)
A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. You can access NOTAMS here: https://plan.navcanada.ca/wxrecall/ *(NOTAM-Avis aux navigatants aériens)*

OBSTACLE (OBST)
All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.
Also called: obstruction *(OBSTACLE)*

PAYLOAD
A system, an object or a collection of objects that is on board or is otherwise connected to a remotely piloted aircraft but that is not required for flight. *(CHARGE UTILE)*

PART IX
The section of the Canadian Aviation Regulations (CARs) that applies to Remotely Piloted Aircraft. *(PARTIE IX)*

RECREATIONAL OPERATIONS
Utilizing a RPAS in the basic or advanced operational environment for fun and not for remuneration or hire. *(OPÉRATIONS RÉCRÉATIVES)*

REMOTE PILOT-IN-COMMAND (REMOTE PIC)
In relation to a remotely piloted aircraft, the pilot having responsibility and authority for the operation and safety of the aircraft during flight time. *(PILOTE COMMANDANT DE BORDD'ATP)*

TERMINAL CONTROL AREA (TCA)
A controlled airspace of defined dimensions that is normally established in the vicinity of one or more major aerodromes and within which ATC service is provided based on the airspace classification. *(RÉGION DE CONTRÔLE TERMINAL)*

TRAFFIC PATTERN
See established traffic pattern. *(CIRCUIT D'AÉRODROME)*

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VARIATION
The aviation term for declination which represents, in degrees, the difference between true and magnetic north at a given location. *(VARIATION)*

VISUAL LINE-OF-SIGHT (VLOS)
Unaided (ex. without binoculars) visual contact at all times with a remotely piloted aircraft that is sufficient to be able to maintain control of the aircraft, know its location, and be able to scan the airspace in which it is operating in order to perform the detect and avoid functions in respect of other aircraft or objects.
(VISIBILITÉDIRECTE)

VISUAL OBSERVER (VO)
A trained crew member who assists the pilot in ensuring the safe conduct of a flight under visual line-of-sight.
(OBSERVATEUR VISUEL)

Introduction

WHAT IS AN RPA?

RPA stands for Remotely Piloted Aircraft. This is the official term in Canada that you may commonly hear referred to as a drone. While these terms can be used interchangeably, Remotely Piloted Aircraft is the term you will find in most government documents and aligns best with international standards.

DEFINING RPA

RPA are defined as “a navigable aircraft, other than a balloon, rocket or kite, that is operated by a pilot who is not on board." RPA come in many different shapes, sizes and configurations and this term refers to the aircraft itself.

Another term you will see is RPAS. They are often used interchangeably but the S refers to “system” and includes all components needed to make an RPA fly. RPAS means “a set of configurable elements consisting of a remotely piloted aircraft, its control station, the command and control links and any other system elements required during flight operation.”

The control station is the device or equipment used to operate and monitor the aircraft in flight. Often it is a handheld controller with control sticks and a screen but other variations of this are often used as well.

The command and control link is the wireless data link that exists between the control station and the RPA to enable the pilot to control and manage the flight as well as receive data from the RPAS, including telemetry and video.

TYPES OF RPA

RPA can be multirotor, fixed wing, single rotor, or combinations of those designs. Each type has their pros and cons and tend to be suited to particular applications or jobs.

	PROS	CONS	APPLICATIONS
MULTIROTOR	• Small footprint • VTOL • Smaller rotors	• Cannot glide or autorotate • Shorter flight time	• Many. Excels in photo/video
FIXED WING	• Long flight time • Efficient • Able to glide	• Requires a launch/ recovery system and space	• Large area scanning and mapping
VTOL FIXED WING	• Small footprint • VTOL • Efficient in forward flight	• Usually larger than other types • High battery usage during landing	• Large area scanning and mapping
HELICOPTER	• Long flight time • High speed	• Large, high speed rotor • Mechanically complex	• High speed or long distance photo/video

VTOL = Vertical Take Off and Landing

RPA Pilot Certificate

WHAT IS AN RPA PILOT CERTIFICATE?

An RPA Pilot Certificate (PC) is the document issued by Transport Canada that allows certain privileges to an individual to operate an RPA. You can think of it as being similar to a permit or license required to operate a car, boat or other aircraft but has additional requirements associated with it, for example, meeting recency requirements.

WHO NEEDS AN RPA PILOT CERTIFICATE?

If you intend to operate an RPA that weighs 250 grams (.55 lbs) or more, you will need to hold an RPA pilot certificate. The requirement is not intent-based (recreational or commercial) but rather risk-based and therefore depends on the weight of the RPA and where you intend to operate. There are two types of PCs: RPA Pilot Certificate - Basic Operations and RPA Pilot Certificate - Advanced Operations. Additionally, flying an RPA outside of Part IX regulations requires a Special Flight Operation Certificate (SFOC) in addition to your Advanced PC.

WHO DOESN'T NEED A PILOT CERTIFICATE?

There are a few scenarios in which a PC is not required to legally operate an RPAS.

Sub 250g RPA

RPA that, at the time of flight, weigh less than 250g are not as regulated as their heavier counterparts. The pilot does not require a certificate to operate and the aircraft does not need to be

registered but this does not mean the category is unregulated. Note that Canadian Aviation Regulation (CAR) 900.06 still applies to sub 250g RPA and is discussed in more detail further on.

Be mindful of the marketing with an RPA close to the weight limit! Adding something like a sticker, memory card or prop guards may be all that's needed to push the RPA over 249g and therefore into the more comprehensive regulatory structure requiring certification and registration

MAAC

MAAC stands for the Model Aeronautics Association of Canada. The organization has been around for decades bringing together model RC airplane, helicopter and drone enthusiasts all across Canada to fly safely at dedicated clubs and events and has an excellent history of safe operations. Flights at MAAC designated fields and events across Canada are exempt from the CARs under conditions listed in the MAAC Exemption.

Indoor and Underground

RPAS flights that take place indoors or underground, such as in a parking structure, are exempt from the CARs as they do not take place in airspace. Note that other laws regarding privacy, trespassing and the criminal code still apply. If you are planning to fly your RPA at an indoor event, you will need permission from the event organizer and the facility. They will require you to have adequate insurance and meet specific safety guidelines.

Tethered RPAS

If an RPA secured on a tether is navigable, that is, its flight path can be controlled aside from minor stability corrections, it is still considered an RPAS and must abide by Part IX CARs. If, however, the aircraft is not navigable in that the lateral directional control is not managed during flight, it is not technically an RPAS and the operator does not require a pilot certificate. In that case, a tethered multicopter is an obstacle to navigation and is regulated under the obstacle regulations in Part VI of the CARs. See Standard 621 for further details on conditions pertaining to obstacles.

BASIC PILOT CERTIFICATE

A Basic Category Pilot Certificate enables a pilot to operate in basic operational environments. The basic environment is considered low risk as it prevents the pilot from operating close to airports, heliports, bystanders and in controlled airspace. The Basic Certificate is a great way to get started in the industry as it requires foundational knowledge but is not a pre-requisite to the Advanced Category Pilot Certificate. Commercial operations can be flown with a Basic Certificate.

ADVANCED PILOT CERTIFICATE

An Advanced Category Pilot Certificate enables a pilot to operate in advanced environments. Advanced environments carry more risk to other airspace users and people on the ground and therefore require a higher level of knowledge to be demonstrated than for basic environments. Holding an Advanced Pilot Certificate provides greater flexibility as it allows the pilot to operate close to airports and heliports, and depending on the specific RPA being flown, in controlled airspace and closer than 30m from bystanders. See Choosing Where to Fly for more information on RPAS permissions. Most pilots using the RPAS for commercial operations will opt for an Advanced Certification as it allows them greater flexibility.

HOW TO GET AN RPAS PILOT CERTIFICATE

To get either a Basic or Advanced Pilot Certification, you will first need to meet the required knowledge requirements by successfully passing a multiple choice exam administered through Transport Canada's online Drone Management Portal. An advanced PC requires an additional in-person demonstrated knowledge and skill assessment called a Flight Review, conducted by an associated Flight Reviewer. Once you have completed all of the applicable requirements for certification, the Drone Management Portal will, upon your payment of the licensing fee, automatically send an email notification and your certificate will be immediately available to you.

Basic Pilot Certification Exam
The Basic Pilot Certification exam consists of 35 multiple-choice questions which you have 90 minutes to answer. You must score at least a 65% to pass. An examination fee is charged for each attempt and if you need to rewrite the exam, you'll have to wait a minimum of 24 hours. Following each attempt, you will be provided with a feedback statement to guide further studying based on the questions that were answered incorrectly.

The exam is open-book and has a lot of extra time built in. This was done intentionally to give candidates the opportunity to research and learn as they encounter challenging questions. Candidates cannot ask for or accept any assistance from others during the examination. The qualification is yours and yours alone so it must be earned on your own as well. Do not save or share questions from the exam. This is a contravention of the CARs and one that is easily proven and fined.

Advanced Pilot Certification Exam
The Advanced Pilot Certification exam consists of 50 multiple-choice questions which you have 60 minutes to answer. You must score at least 80% to pass. An examination fee is charged for each attempt and if you need to rewrite you'll have to wait a minimum of 24 hours. Do not feel discouraged if the exam takes you more than one attempt to pass as the expectations are higher for advanced applicants. The exam is open-book but you cannot ask for or accept any assistance from others during the examination.

Once you have successfully passed your advanced written exam, you will be issued a Basic Certificate. There is, however, a second step required in the Advanced Certification process called a Flight Review. Until you have demonstrated that you meet the flight review requirements, you will only be able to operate, practice and develop skills under the limitations of a Basic Certification.

Flight Review
A flight review is a holistic assessment of your procedures, knowledge and flight skills. You will meet with a Transport Canada Certified Flight Reviewer in-person who will ask you a series of knowledge testing and practical questions and require you to fly some basic flight skills to demonstrate you are qualified to operate your RPAS safely in riskier environments.

Once you have successfully met the Flight Review requirements, the reviewer will submit your results into the Drone Management Portal. You will be able to view and save your Pilot Certificate - Advanced Operations directly from logging into your account on the portal. It is important to note that just because you have passed your flight review, your privileges as an Advanced Certified Pilot will not become effective until you log into the DMP and remit your fee.

During the flight review you will be graded as either having met or not met the requirements for the following areas:

- describe the site survey process,
- describe emergency procedures that apply to flying an RPAS, including lost-link procedures and procedures to follow in the event of a fly-away, including who to contact,
- describe the method by which to inform Transport Canada of an incident or accident,
- successfully perform pre-flight checks of their RPAS,
- perform a take-off,
- demonstrate the ability to navigate around obstacles,
- demonstrate the ability to recognize distances, and
- perform a landing.
- If the reviewer determines you have not met the requirements for any one or more of the nine items, your review is deemed unsuccessful and you will need to retake the full review at least 24 hours later.

Most organizations conducting reviews will have some preparatory material for you prior to your review so you know what to expect and what to bring. The review should be completed as close as

possible to your normal operational practice. Ensure you have all the required operational documents as well as Standard Operating Procedures (SOPs) that comply with the CARs requirements, at a minimum.

Flight review cost is at the discretion of the reviewer. This payment is due prior to the flight review and cannot be refunded if the candidate fails. Fees charged for the flight review may vary and are not regulated by Transport Canada. Due diligence is required when choosing a flight reviewer.

HOW TO KEEP YOUR PILOT CERTIFICATE CURRENT

Once you have received your Pilot Certificate, to be able to exercise the privileges of your PC, you will need to maintain recency. This means that, every 24 months, you must participate in a recurrent training activity to keep your RPA certification valid. Your 24-month currency resets from your most recent recurrent training activity.

There are several options available to you. You may:

- successfully write either the basic or advanced written exam,
- successfully complete a flight review,
- attendance at a safety seminar endorsed by Transport Canada,
- completion of a 921.04 compliant recurrent training program, or
- completion of a Transport Canada endorsed self-paced study program.

While your pilot certificate will act as proof of recency for the first 24-month period, you will need to keep proof of recency with you for all operations after that initial period. Keep any proof of meeting recency requirements for 24 months after completing the recency activity.

Abiding by the Canadian Aviation Regulations and other Canadian laws at all times is also an important requirement in maintaining your certification.

SPECIAL FLIGHT OPERATION CERTIFICATE

A Special Flight Operation Certificate (SFOC) is issued by Transport Canada for operation types that aren't specifically covered by Part IX of the CARs.

The operator applies for their SFOC which is required for any of the following situations:

- Flying an RPA over 25 kilograms (kg).
- Flying your RPA beyond visual line-of-sight (BVLOS).
- Flying if you are not a Canadian citizen or permanent resident of Canada.
- Flying your RPA at heights above those allowed by Part IX of the CARs.
- Flying more than five RPA at the same time
- Flying at a special aviation event or an advertised event
- Flying your RPA carrying dangerous or hazardous payloads (e.g. chemicals)
- Flying closer than 3 NM from a military aerodrome

To apply for an SFOC, first complete the SFOC application form. After submitting it to the RPAS Centre of Expertise, you will receive a reply with a checklist of documentation you must provide to support your application.

Apply for your SFOC as early as possible as it may take up to 30 business days to process depending on the number of other applications in the queue or if you are missing any information in your application.

An SFOC validity period and area of coverage depends on what you apply for and the reasonableness of your request. Ask for what you want and be prepared to work with the Transport Canada inspector that is assigned to your application to find a solution. Give yourself as much time as possible to work through this process.

TRAINING OPTIONS

While training is not legislated in the CARs in the certification process for either basic or advanced pilots, it is considered a best practice in the industry and is highly recommended. It may be possible to pass the online exams without knowledge training but it will be quite challenging for most individuals. Even more importantly, knowledge gaps become evident in the flight review process and prevent some candidates from getting an advanced certification.

If you are looking for a Training Organization, Transport Canada maintains a list of self-declared training program providers on their website. Some provide in-person training, some online and some a combination of both. Not all training programs are created equally!

When choosing a school, ask for recommendations from other pilots you know, look at online reviews, talk to the instructors and look for training organizations that have a strong presence so you can be sure they'll be around to provide you with ongoing support.

Who's who?

There are several organizations that one should be familiar with as an RPAS pilot. Each one plays a role in making Canadian airspace and the area below it safe for all Canadians to use and enjoy.

TRANSPORT CANADA

Transport Canada is the federal department within the Government of Canada that is responsible for developing regulations, policies and services of road, rail, marine, and air transportation in Canada. Within Transport Canada Civil Aviation there is a group of experts who have been brought together to work as part of the RPAS Task Force. The RPAS Task Force develops, implements, monitors and communicates the RPAS initiatives in Canada including publishing Part IX of the Canadian Aviation Regulations that apply to RPAS and any future RPAS regulations. The majority of the Task Force works out of the Transport Canada head office in Ottawa, Ontario but there are inspectors across the country as well. The Regional RPAS Center of Expertise (RCE) is responsible for dealing with all the operational tasks regarding RPAS operations, as well as oversight and enforcement.

NAV CANADA

NAV CANADA is a private organization that has been delegated by Transport Canada the responsibility to manage the Canadian civil Air Navigation Service (ANS).

Their facilities include area control centres (ACC), airport control towers, flight service stations (FSS), flight information centres (FIC), and Community Aerodrome Radio Stations (CARS). When you

speak to someone in Air Traffic Control (ATC) at an airport, they are an employee of NAV CANADA.

NAV CANADA employees provide services in commercial and general aviation, and to both traditional and remote pilots. These services include air traffic control and permission to access requests, flight information, weather briefings, aeronautical information services, airport advisory services and maintaining electronic aids to navigation.

Once you are a certified RPAS pilot, NAV CANADA will be an organization you work with when you need to access the ANS and operate in controlled airspace.

TRANSPORTATION SAFETY BOARD

The Transportation Safety Board (TSB) is the independent federal agency that investigates incidents with the goal of preventing reoccurrence. They do not lay blame, but instead aim to identify the root cause of abnormal occurrences to establish trends and amend best practices to prevent repeat incidents.

Further in this document is guidance that will provide more information on how to deal with RPAS emergencies and when it is important to notify the TSB. There is also more information in the Aeronautical Information Manual (TC-AIM).

PARKS CANADA

Parks Canada is an agency of the federal government who, among other initiatives, manages the National Parks and National Historical Sites in Canada. To protect the enjoyment and integrity of the parks, Parks Canada has implemented RPAS restrictions. These rules apply to all RPA regardless of weight. Unless you have received prior permission, you as the pilot cannot be within the park boundaries while operating an RPAS. The full details of the RPAS restrictions are linked in the Resources section.

PROVINCIAL AND MUNICIPAL GOVERNMENTS

Provincial and Municipal governments may enact bylaws that restrict the use of RPA in certain areas and/or under certain conditions. These laws typically control the ground areas accessed by the RPAS or crew. Providing these regulations do not contravene the federal regulation, they are enforceable and must be abided by. Common restrictions include access to parks, particularly when these parks are close to airports, and requiring film permits or permission prior to using City property for launch and recovery of your RPA.

FIRST NATIONS GOVERNMENTS

To strengthen relationships with First Nations communities, many operators will connect with local First Nation governments prior to conducting any flights, work or research near or within their traditional territories

TIP: If you believe your City has enacted RPAS bylaws that aren't consistent with Federal regulation, reach out to the national industry association representing the RPAS sector, Unmanned Systems Canada / Systèmes Télécommandés Canada. Members of USC-STC are able to provide support in communicating with government at all levels to effect change.

Respecting Canadian Laws

CANADIAN AVIATION REGULATIONS

The Canadian Aviation Regulations (CARs) contain the rules that apply to the aviation industry to keep the airspace and the ground below it safe. These regulations are divided into Parts with the rules relating to RPAS in Part IX – Remotely Piloted Aircraft Systems. The regulations under Part IX are divided into subparts as follows:

- **900—General provisions for all RPAS**
- **Subpart 1 - 901 - Small RPAS (>250g to 25kg)**
- **Subpart 2 - 902 - Reserved**
- **Subpart 3 - 903 - Special Flight Operations -RPAS**

Each regulation is given a number which tells you a bit about how the CARs are organized.

Part	Regulation (0) Standard (2)	Subpart	Decimal	Order of Regulation
9	0	1	.	22

For example, CAR 901.22 indicates it is the twenty-second regulation in subpart 1 in the General Operating and Flight Rules Section of Part IX. Some regulations have related Standards which will be indicated by a change to the second digit in the identifier. Standards describe ways of achieving the regulation or criteria for meeting a regulation. Transport Canada issues Advisory Circulars (ACs) to help the civil aviation community understand how to comply with current regulations and standards in aviation.

At present there are two RPAS standards published under Part IX.

Standard 921
Small Remotely Piloted Aircraft in Visual Line-Of-Sight (VLOS)
Standard 921 gives an overview of VLOS standards for training,flight reviews and pilot certification and flight reviewer qualifications.

Standard 922
Remotely Piloted Aircraft Systems Safety Assurance
Standard 922 outlines the technical requirements that manufacturers must meet in order to declare their RPAS suitable for advanced operations such as operations in controlled airspace or near or over people.

As RPAS operations develop, Advisory Circulars will be published in the civil aviation reference centre. There is currently an Advisory Circular related to RPAS safety assurance. AC-922-001 helps to clarify how manufacturers can meet Standard 922.

While it is essential to abide by the Canadian Aviation Regulations every time you fly, don't forget that as Canadians, there are other laws you must also follow to operate legally.

PRIVACY REGULATIONS AND BEST PRACTICES

In Canada, there are several laws that refer to privacy rights. The Personal Information Protection and Electronic Documents Act (PIPEDA) sets the ground rules for how personal information can

be collected and applies to commercial, for-profit activities. Not all provinces abide by PIPEDA but have substantially similar provincial privacy laws. In public spaces, permission is required prior to taking an individual's photograph for commercial purposes. They have a right to know that it is happening, and what the intended use will be. In private spaces, people have a reasonable expectation of privacy that must be respected. It is best practice to inform the general public of your flights prior to them taking place so they may have an opportunity to remove themselves (or things they do not want there to be footage of!) prior to take-off.

TRESPASSING

Each province in Canada has its own trespass legislation. In general, trespass laws protect landowners from unlawful entry onto their property and give the owner the right to order persons to leave their property or to have trespassers arrested by the police. Trespassers may also be subject to fines or civil penalties.
You should make all efforts to request permission from the land owner before conducting flight operations. If you are asked to leave a property by the owner or their representative, you must do so. For more detailed information, consult the trespass legislation applicable to each province before you fly.

CRIMINAL CODE

The Criminal Code of Canada lists several offences that RPAS pilots could be charged with if they operate in a careless manner. Some examples are listed below:

- **Sec. 77**—Endangering the safety of aircraft or airports
- **Sec. 430**—Mischief (Interfering with any person's lawful enjoyment of their property)
- **Sec. 320**—Dangerous operation of a conveyance (aircraft) including impairment

DEALING WITH NUISANCE RPA

As RPA become more popular, it is inevitable that there will be conflicts between RPA and the public. In some cases these may be criminal in nature but more often the complaints will relate to privacy, trespassing or contravention of the Canadian Aviation Regulations.

TAKING THE LAW INTO YOUR OWN HANDS

You may be tempted to throw something or shoot a projectile at an RPAS, but this will only end up with the police knocking at your door.

It is an offence under the Criminal Code to damage an aircraft, including RPAS, or to interfere with its flightpath. The Aeronautics Act definition of an aircraft includes RPAS and therefore you could be charged for your actions against an RPAS. You could also be charged if you interfere with the RPAS and it injures someone or damages property. Intentional damage to someone's RPAS could result in a charge of Criminal Mischief (Sec. 430) which carries a maximum penalty of 10 years in prison. Additionally, the batteries onboard the RPA do not handle impacts well and can result in a fire if not properly dealt with immediately after a crash.

MAKING A COMPLAINT

If an RPA is doing something that has or could likely cause a serious threat to people or to aircraft you should immediately call 911.

If you feel that an RPAS pilot is contravening privacy or trespass laws and no one is in immediate danger of harm:

- Call your local police department's non-emergency number.
- Take note of the shape, colour and size of the RPA.
- Watch to see where the RPA goes. If it lands, and is safe for you, take note of any associated persons or vehicles (ex. record the license plate, if possible).
- Police will take all the details and work with Transport Canada Enforcement officers as necessary.

If you think an RPAS pilot is contravening the Canadian Aviation Regulations (flying too high, too close to an airport or beyond their line of sight, etc.), you can provide all of the details to Transport Canada online via the TC website.

ENFORCEMENT AND FINES

Enforcement of the Canadian Aviation Regulations (CARs) is conducted by Transport Canada as well as municipal, provincial and federal peace officers such as the Royal Canadian Mounted Police (RCMP). Peace Officers, Customs and Border Service Agents and The Minister (or their delegates) are all empowered to demand to see a pilot's aviation documents under the CARs. Contravention of CARs can result in fines of up to $5000 for an individual and $25 000 as an organization. Breaking multiple laws at once can quickly add up to a hefty fine! (not to mention the negative publicity)

Contravention of Criminal Code or Provincial laws can happen concurrently with your CARs violations and can compound fines or

or other penalties. Ignorance is not an excuse! Refresh your memory regularly and always ensure you have permission for accessing the land you are operating from and for the airspace you're operating in.

INSURANCE

Having insurance for your RPAS is not a specific requirement under the CARs. However, as with many activities where there is risk of damage or injury, it is advisable to have appropriate insurance coverage as a form of personal and professional financial protection. If you operate your RPAS for commercial purposes, many clients will require you to have an appropriate level of liability insurance oftentimes in excess of $1 million. They may also ask to be named on the certificate.

If you operate your RPAS recreationally, it would also be prudent to have some level of liability insurance in the event there is an incident involving your RPAS. You may decide that you also want "hull coverage" which is insurance under certain conditions for damage
to your equipment. Some manufacturers offer this as an add-on product.

Do not assume your household insurance provides coverage related to the use of your RPAS.

Have the discussion with your household insurance provider about your intended RPAS use. Due to the unique nature of RPAS and the risks they present, there are some insurance brokers who specialize in offering RPAS coverage (both liability and hull) for your specific needs.

General Operating Information

As the pilot of your RPA, you are responsible for the safe use of your equipment. You are sharing the skies with other air traffic and thus Transport Canada views you as a pilot and expects you to operate within the aviation regulatory framework (CARs). While to some this may seem overly burdensome and complex for a simple hobby, the fact of the matter is your RPA is occupying the same airspace as planes, helicopters, gliders, parachute jumpers, paragliders, etc. and thus you need to understand how to safely and responsibly operate in that same space.

GENERAL OPERATING LIMITATIONS

CARs Part IX contains many requirements and limitations related to the use of your RPAS. Below you will find the ones that define many of the limitations of your operation. As an RPAS pilot, you:

- must not interfere with the established traffic pattern at registered land or water aerodromes listed in the Canada Flight Supplement or Water Aerodrome Supplement.
- must not fly within 3 nautical miles of a military aerodrome unless an SFOC has been issued.
- must not fly beyond visual line of sight.
- must not fly at night unless the RPA is equipped with position lights.
- must not fly above 400 feet AGL unless operating within 200 feet laterally of a structure. In this scenario the pilot may operate up to 100 feet above the height of the structure while remaining within the 200 foot lateral zone around the structure.
- must not exceed the manufacturer's equipment limits (temperature, altitude above sea level, wind speed, and others as defined in the RPAS manual).

BASIC OPERATIONAL ENVIRONMENTS

In addition to the general operating limitations above, pilots who obtain their Pilot Certificate - Basic Operations, must operate within the following limits.

- Not within 3 nautical miles of an airport
- Not within 1 nautical mile of a heliport
- Not in controlled airspace -Remember controlled airspace around an airport may extend much further than 3 nautical miles!
- Not closer than 30m (100 ft) from bystanders

CAUTION! -The RPAS manufacturer's no-fly zones or geozones around aerodromes in their apps do not relate to the legal boundaries of where you can fly!

> **TIP! Use the NRC Drone Site Selection Tool to check if the area you want to fly in is acceptable for Basic Operations.**

ADVANCED OPERATIONAL ENVIRONMENTS

In addition to the general operating limitations, pilots who obtain their Pilot Certificate -Advanced Operations may operate in higher risk environments if their RPAS meets specific Safety Assurance requirements. The advanced environments are listed below:

- **Within 3 nautical miles of an airport**
  Advanced pilots must follow established procedures for these areas as detailed in the Drone Site Selection Tool and CFS.
- **Within 1 nautical mile of a heliport**
  Advanced pilots must follow established procedures for these areas as detailed in the Drone Site Selection Tool and CFS.
- **Within controlled airspace** (with an approved RPAS model and permission from the airspace authority)

See the Nav Canada NAV Drone App at :
https://www.navcanada.ca/en/flight-planning/drone-flight-planning/nav-drone-support.aspx

- **Within 5-30m of bystanders** (with an approved RPAS model)
- **Less than 5m from** (considered over) bystanders (with an approved RPAS model)

TIP! Use the NAV Drone or NRC Drone Site Selection Tool to check if the area you want to fly in is acceptable for Basic Operations.

<250g RPA

A common misconception in the industry is that RPA under 250 grams are not regulated. While it is true that they are minimally regulated, there is an important general regulation that requires all RPA to operate in a safe manner with respect to people and other airspace users.

CAR 900.06 states “No person shall operate a remotely piloted aircraft system in such a reckless or negligent manner as to endanger or be likely to endanger aviation safety or the safety of any person.” Essentially, this rule means don’t be an idiot when you’re flying your RPA. In practice, this lack of prescriptive “do this/ don’t do this” regulation can make choosing where and when to fly harder than it is for heavier RPA.

RPA that weigh less than 250 grams can operate in controlled airspace, close to and over people, and near airports and heliports, however if the CARs prohibit any aircraft from operating in a specific area, then even sub 250 gram RPA may not be operated there. The restricted airspace, for example, around Parliament Hill in Ottawa. There is, however, a difference between what is legal and what is safe. It is still the pilot’s responsibility to prevent hazards to other airspace users and people on the ground, so be smart about where and when you choose to operate.

Remember that all other regulations including privacy, trespassing, and park/city bylaws still apply to pilots of sub 250 gram RPA.

STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) are a set of preplanned steps that ensure that critical procedures are carried out in the same manner and order everytime. At a minimum, SOPs may be generally similar for Small RPAS operations when it comes to flight planning but they will have customized sections relating to specific aircraft controls, settings and actions to be performed in the event of an emergency.

SOPs assist with the complex task of operating an RPAS and can also:

- Reduce operating costs
- Reduce training costs
- Allow individuals up to large companies to function consistently and universally
- Reduce wear and tear on equipment
- Improve safety
- Ensure adherence to rules and regulations
- Reduce the risk of miscommunication
- Ensure consistency in operating procedures amongst different operators

SOPs can be a comprehensive procedural document or they can be as simple as a step by step checklist or flowchart.

In accordance with the CARs, Standard Operating Procedures for Basic and Advanced RPAS operations (for fun or for work!) must cover Normal Procedures, Emergency Procedures and a Site Survey as detailed in the following sections and be used every time.

NORMAL PROCEDURES REQUIREMENTS

Normal Procedures are the steps that are important to completing a safe and successful flight. As a minimum your procedures should be a list of key items on a checklist. As an example a pre-flight checklist could list items such as:

- Crew briefing on roles and use of emergency equipment
- Sufficient RPA battery level
- Maximum safe distance the RPA can operate
- GPS lock requirements
- Propeller and structural inspection
- Loss of communications settings

Normal Procedures must cover off the following area as applicable:

- Pre-flight checks
- Take-off
- Launch
- Approach
- Landing
- Recovery
- Post Flight procedures
- Crew Communications

TIP! The development of Normal and Emergency procedures can range from simple to complex. This is an area that if you are unsure, talk to more experienced pilots, or consider attending a ground school.

EMERGENCY PROCEDURES REQUIREMENTS

Emergency Procedures are those steps that must be performed when things don't go according to plan. In fact, we can actually plan for the unexpected by thinking about possible emergencies before they happen and laying out a series of steps to handle the situation.

Emergency procedures can be detailed in a checklist but unlike normal procedures that are followed every flight, emergency procedures should be reviewed frequently to ensure the crew understands what the steps are and how to complete them. Mentally stepping through emergency procedures regularly helps a crew to limit stress during an actual emergency.
Emergency Procedures must address at least the following situations:

- a control station failure,
- an equipment failure,
- a failure of the remotely piloted aircraft,
- a loss of the command and control link,
- a fly-away,
- flight termination.

SITE SURVEY REQUIREMENTS

The purpose of the Site Survey is to increase your situational awareness and give a pilot a solid understanding of the key components of the operational flight area as well as the areas around and above your intended flight path in the event of an emergency. Site Surveys are often detailed on maps to make it easier to picture in your mind where obstacles, airports and security areas are in relation to your flight area. The completion of a Site Survey is a requirement for both Basic and Advanced Pilots for every flight.

A complete Site Survey must include:

- the boundaries of the flight operation,
- the type of airspace and the applicable regulatory requirements,
- the altitudes and routes to be used on the approach to and departure from the area of operation,
- the proximity of traditional aviation operations,
- the proximity of aerodromes, airports and heliports,
- the location and height of obstacles, including wires, masts, buildings, cell phone towers and wind turbines,

- the predominant weather and environmental conditions for the area of operation,
- the horizontal distances from persons not involved in the operation.

CONDUCTING A SITE SURVEY

Once you have determined where you would like to fly your RPA, there are many things you will need to consider and assess in order to ensure your operation is safe and legal. We discussed the requirement to secure permission to operate on the ground as well as in the airspace around your site, but in addition to that, you will need to ensure you are fully aware of what else you may encounter while flying. This site assessment or a site survey will make sure you have the information and knowledge of the space you are operating in, and is also a requirement before each flight. Typically, this site survey will be conducted in two stages, remote site assessment and on-site assessment.

Remote Assessment

Remote assessment is the process of collecting information about your planned flight location before you arrive. It is good practice to document your site survey so that you can refer to it for details in the future and to have the information on hand in the event it is required on the day of your flight. Typically, this will involve using on-line tools and apps that help you understand things such as:

- Location address,
- Location coordinates,
- Date and timing of flight,
- Boundary of your flight operation,
- Airspace,
- Distance to the nearest airports / heliports / seaports / model airplane fields,
- Property Owner and required permission,
- Distance from bystanders and requirement for ground personnel,
- Weather forecast,

- Visual observer requirements,
- Equipment requirements,
- Access restrictions,
- Terrain,
- Reviewing and respecting NOTAMs that have been issued in your location.

Having a good awareness of what to expect once on site will help eliminate surprises and ensure you are appropriately prepared. Below is a list of tools and apps you may find useful in performing your site survey:

Recommended Websites:

—For Site Assessments:

- Transport Canada RPAS Site selection Tool
- VFR Navigation Charts (VNCs)
- Google Maps
- Google Earth

—For Wind and Weather:

- Windfinder
- Aviation Weather Website
- Windy

Useful Apps:

- FLT PLN GO
- UAV Forecast
- Drone Pilot Canada
- Windy
- Tesla Magnetic Field Recorder
- NAV CANADA NAV Drone app

ON-SITE ASSESSMENT

When you arrive at your flying location, you should complete your Site Survey. This will validate your learnings from your remote survey but also includes the site-specific items to determine if it is safe to operate your RPAS. Additional items to consider and hazards

to look for as part of your on-site survey include:

- Actual weather and wind conditions,
- Identifying a safe and secure launch site,
- Identifying alternate or emergency landing site options,
- Identifying potential privacy risks (backyards, neighbours, nearby condos, office towers, sensitive areas, etc.),
- Identifying large metal objects and structures which may cause sensor interference,
- Determining the proximity of bystanders and risk of incursion,
- Obstructions and obstacles (trees, fences, poles, overhead wires, towers, transmission towers and lines, bridges, bodies of water etc.),
- Proximity to cell phone and broadcast towers,
- Electromagnetic interference (radio, wireless, high-voltage, microwave, etc.),
- Compass directions in relation to launch direction,
- Location and direction of the sun. It is preferable to have the sun behind the work area,
- If possible, select a launch location that is downwind of your target flight area so you will be flying with the wind if you have a low battery issue.

Depending on the complexity of the RPAS and the general nature of the work, the SOPs may vary in size. It may range from only a few pages to several dozen in size and scope. They should be organic documents that change over time as new processes and best practices are developed. Whatever method you create for your SOPs, do it in a way where you'll actually use them on every flight. It's not just good practice. It's in the regulations for both basic and advanced pilots.

DEALING WITH TOUGH FLIGHT CONDITIONS

There are a number of situations where operating your RPAS will present additional challenges and require extra measures to ensure a safe flight. As the Pilot in Command, it is your responsibility to

operate your RPAS safely and not to endanger others. You must understand the capabilities and limits of your equipment and be aware of your own capabilities too. Below are some of these situations where you may be faced with tough flight conditions and how to prepare and manage them.

FLYING AT NIGHT

Flying your RPA at night is permitted without requiring any additional authorizations. However, there are additional precautions and steps required in order to do so safely.

- Your RPA must be equipped with lights which allow you as the pilot and/or a visual observer to determine its position.
- You are allowed to use night vision aids providing they can see the full spectrum of light.

Flying in reduced light and in darkness can be more challenging and introduces more risks. It is a good idea to scout your flying location during daylight hours so that you can clearly identify any obstructions and confirm that you will be able to operate your RPAS safely.

Flying at night also impacts your depth perception and orientation of the RPA, so extra care must be taken to ensure you remain in control of the RPA at all times. Having an observer can be very helpful for night flights. It is also helpful to have some means of lighting your launch and landing area. A good flashlight, headlamp or electric flares work well for this! Reducing the brightness on your control station display can help to preserve your night vision but be aware that looking back and forth between your screen and aircraft will require more time for your eyes to adjust than during daylight. Muted white light rather than red is preferred for reading checklists and manuals at night as the red colour can obscure coloured text, causing you to miss critical information.

TIP! If adding 3rd party lighting systems to your RPA, ensure it is done in accordance with the manufacturer recommendations. Pay attention to warranty or flight issues that may arise from electrically tapping into the drone if the light isn't battery-powered, added weight, and potential contact of the light with the props.

COLD WEATHER OPERATIONS

Canada has a range of seasons and weather conditions that will affect your RPAS. Flying your RPA in cold weather requires special attention and preparation.

Cold weather operations have a severe impact on both your equipment as well as yourself and your crew. Manufacturers provide operational temperature specifications and limitations for their RPAS and it is important to be aware of and respect these limits. Do not attempt to fly in temperatures beyond those specified by the manufacturer. It is also important to note that there can be a range of minimum and maximum temperatures for the various components of your RPAS. For example, some RPA are capable of flying at -20C but the cameras they carry may only be rated for -10C.

Batteries, for both your RPA and other pieces of equipment such as displays and cellular phones, are particularly vulnerable to the cold. Your flight times may be significantly less than published by the manufacturer, so it is important to monitor your battery capacity closely while operating in cold weather.

TIP! It is possible for a battery to be showing ample flight time remaining and then suddenly drop down to critically low levels, putting your drone and potentially others at risk.

It is not only the batteries in your RPA that will be impacted but also those in your controller and your display device. Keep batteries warm until you are about to use them and be sure to monitor the levels often. Many RPAS available today use a tablet or phone as the display. You should be aware of how your specific RPA will respond should that display shut off mid-flight. In most cases, the RPA will continue to operate safely and flight stability is not predicated on having a functioning tablet or phone connected to the ground control station but it will impact your situational awareness.

TIP! Keep spare batteries inside your jacket when operating in cold temperatures. Avoid shock-cooling and shock-heating of the batteries by ensuring they warm and cool slowly.

It is also important to not charge your batteries in cold temperatures. This can lead to improper charging and the battery can appear to be fully charged when in fact, it is not.

Also be aware of the impact the cold will have on you as the pilot and your crew. It is important to dress properly for the conditions while ensuring your ability to manage the RPAS controls and maintain visual sight of the RPA are not compromised. Extreme cold can impact your thought processes leading to poor decisions and mistakes.

In cold, moist environments, there is also the risk of icing. When moisture in the air freezes on components of your RPAS it can seriously impact the performance and handling of your RPAS. Ice build up on a propeller can very quickly lead to loss of control of your RPA.

It is also important to properly protect your equipment after you have been flying in the cold. A warm vehicle or house can cause condensation, which in turn can damage sensitive sensors and electronic components. When bringing equipment in from the cold,

it is recommended to keep it in travel cases and bags for several hours to allow your gear to slowly warm up.

WINDY CONDITIONS

When preparing to fly your RPA, pay close attention to the wind. Many of today's RPAS units are controlled by sophisticated electronics and sensors which provide flight control assistance in adverse conditions such as strong winds.

Wind is affected by the terrain and features around you. Be aware of where the prevailing wind is coming from and its strength. If you are in a field protected by trees or other tall structures, you may not be aware of the full wind force above the trees. It is also important to be aware that the wind you experience on the ground is not the wind your RPA will be encountering once airborne. Typically, if it is windy on the ground it will be significantly more windy higher up. When planning your flight, pay close attention to the wind forecast.

If you are flying in a flight mode that relies on GPS, it is likely that your RPA will be able to compensate for the windy conditions and wind gusts but only to a certain limit. Therefore it is important to understand your RPAS manufacturers' stated wind limits. Should the GPS on your RPA fail or GPS mode is not available, flying in windy conditions will require a lot more skill, concentration, and understanding of how your RPA will respond to wind. This will in turn have an impact on you as the pilot because your level of focus and concentration will be amplified. You may not be able to sustain that level of focus for an extended period of time. If you are unsure of how your RPA will operate in the wind when GPS is not available, it is good practice to find a large open space on a slightly breezy day and practice flying in what is more commonly known as 'Attitude' or 'ATTI' mode. You'll find that while the RPA remains in a level attitude, it moves in the direction of the prevailing winds when you take your hands off the control sticks. This is why it is crucial that operators remain vigilant at all times, especially when operating in automated flight modes such as mapping or waypoint flying.

Never walk away from your control station and always be ready to take manual control of your RPA at all times.

TIP! It is good practice to have an anemometer with you to help accurately measure the wind conditions at ground level.

REMOTE LOCATIONS

Remote locations can present risks and conditions that we are not used to or expect. When operating at such locations, in addition to following all your standard checks and operating procedures maintain vigilance and ask yourself these questions to prepare:

- Does someone know where you are and when you are to return?
- Do you have adequate first aid supplies?
- Do you have adequate fire prevention or extinguishing devices?
- Are there nearby lakes or waterways which may have seaplane activity?
- Do you have a plan to deal with wildlife?
- Do you have cell service in the event of an emergency?
- Are you prepared to stay overnight in the event of a flat tire or lost keys, for example?
- Are you 100% sure you have packed all the required gear?

RADIO AND MAGNETIC INTERFERENCE

Electromagnetic Interference (EMI) is unwanted electrical “noise” that interferes with electrical equipment. EMI that specifically interferes with radio signals is called Radio Frequency Interference (RFI). Since most of today’s RPAS use unprotected frequencies for the Command and Control (C2) links, it can come from other radio communications equipment such as other RPA or RPAS controllers nearby, WiFi devices, or from motors, powerlines and industrial equipment. Strong EMI can also affect the compass on the RPA.

RFI/EMI can reduce the range of your drone/controller communication link or cause it to lose connection all together at times. Watch for signs of lag or the video signal breaking up as this is an early indicator of possible communication problems and lost link.

TIP! Use your Site Survey to assess potential sources of EMI/RFI. Your RPAS may warn you of strong interference, or your cell phone may be used to understand the number of Wifi hotspots around your flight location.

If you experience communication issues, check the following items:

- Ensure your communication antennas on your control station are properly positioned and that they have a clear line of sight to the RPA.
- Look for radio towers or other sources of possible interference such as WiFi connected devices near you and try to move away or eliminate these potential sources.
- Some RPAS allow you to change frequency bands or search for channels with less interference. Check your user manual to determine if your RPAS has interference mitigation options.

Always be prepared for a loss of link or a loss of GPS due to interference. By making sure you have a plan for these emergencies and that you have pre-programmed your RPA to act in a predictable manner should you lose link or GPS signal. Refer to your user manual to understand the lost link handling capabilities of your RPA and the way to set these up.

Tip! When flying indoors or under objects such as bridges or a tree canopy, ensure that you program your multirotor to "hover" if you lose your communication link rather than return to home (RTH). RTH can climb the aircraft initially to a pre-programmed "safe" altitude for a return flight, which may not be safe if you're under obstacles!

SOLAR WEATHER

The sun generates its own weather systems that include solar flares spewing highly-charged electrical particles into space. Solar winds then blast these particles towards the earth. The Earth's atmosphere largely protects us from these storms, but the electrically charged particles can affect radio communications and even disrupt power-lines. Global Positioning Satellite (GPS) signals are often affected to a greater degree by solar weather as they rely on precise models to compensate for the earth's normal ionospheric effects.

GPS systems are calibrated to normal solar activity but during periods of high solar activity you can expect:

- A loss of accuracy in your GPS even with a large number of satellites
- More noticeable GPS accuracy and reception issues at northern latitudes
- Dual frequency GPS to be less affected unless the solar activity is very high
- Loss of satellite reception when the solar activity is very high
- Interference or loss of C2 links

Solar activity is classified on a scale of 0-9 called the Planetary K-index or Kp-index. If the Kp index is 4 or above, there is high solar activity and pilots should take this into consideration during their site survey. There are several resources to check the Kp index. The NOAA Kp index website is a useful tool for this and can be found in the resources section.

Choosing Where To Fly

As an operator of an RPAS, you are responsible for following the rules that help keep people and aircraft safe by ensuring that the area you choose to fly in is safe and legal. There are ever-expanding uses of RPAS ranging from backyard flying, capturing cinematic beauty shots, RPA racing, commercial applications like inspections, and of course, just for fun. No matter what the intent of your operation, as the pilot in command (PIC), you must ensure that you operate your RPAS safely within that airspace and that you are allowed to do so. The National Research Council has created an interactive map called the Drone Site Selection Tool. This map helps drone operators understand airspace and find out where to fly. It is for your convenience only.

AIRSPACE CLASSES

Airspace in Canada is categorized into classes designated by the letters A through G.

Airspace begins immediately above ground level all across Canada. Transport Canada has clearly defined the requirements for both Pilot Certifications and the RPAS they are using in various classes of airspace.

Class A and B are controlled airspace and begin at 18 000’ and 12 500’ respectively. Small RPA have bigger problems than airspace permission if they’re at these altitudes!

C, D and E airspace are controlled airspace that typically surround airports. These control zones typically extend to 3000’ above aerodrome elevation (AAE). The lateral dimensions of control zones vary, although most are circular. Check the Drone Site Selection Tool for airspace class and dimension information.

In order to operate in controlled airspace classes C, D, and E, you
- must get permission from the airspace authority,
- maintain an Advanced Pilot Certificate and,
- have an RPAS that has been declared safety assured for this category.

Class F airspace is special use airspace and is further categorized as:
- Advisory (CYA)
- Restricted (CYR)
- Danger (CYD)

Class F CYAs will either be controlled or uncontrolled based on the classification of the surrounding airspace. If surrounded by class G airspace, is considered a basic environment. Although rare, if surrounded by Class C, D or E airspace, it will be considered an advanced environment and require airspace permission.

Class F CYR will require permission from the user/controlling agency, not NAV CANADA. Information on this authority can be found in the Designated Airspace Handbook or the Drone Site Selection Tool.

Class F CYD airspace is restricted airspace over international waters. Permission from the user/controlling agency is required.

Uncontrolled airspace is Class G and makes up most of the airspace below 400ft in Canada. Basic and Advanced RPAS operations are allowed in uncontrolled airspace provided the requirements of the certificate are maintained. (e.g. maintaining distance from bystanders, maximum height, etc.).

GETTING PERMISSION

To operate your RPAS legally, you need to ensure you have permission to access the ground you're using for take-off/launch and landing/recovery, as well as in the airspace in which you are flying.

Airspace Permission
Requesting permission to operate in controlled airspace is done via an online application form on Nav Canada's website or app referred to as NAV Drone .

You will be required to provide basic information with respect to the location and the nature of your request as well as additional details pertaining to the operation including procedures in the event of an emergency (i.e. fly-aways). This request should be submitted well in advance of your planned operation as it can take up to 14 days for it to be reviewed. That being said, using the app they are able to get back to you within a few days, hours or even minutes. A heuristic is that the closer you get to the airport/heliport, the longer it will take to receive approval. Upon review, NAV CANADA may approve your operation as requested, approve it with some restrictions, request additional details before making a decision, or reject your request and not grant you permission. You will receive a reply via the NAV Drone app that contains your authorization and any conditions that apply.

Note: in addition to operating a drone with a Safety Assurance Declaration for Controlled Airspace, you need to have proof that you have NAV CANADA's approval and it is your responsibility to ensure you get it. It is the only way to ensure your operation will not interfere with other air traffic and that other air traffic will not interfere with your operation.

Property Owner Permission
In order to conduct a safe and legal RPAS operation, it is important to ensure you have permission for the property where you are operating your RPAS. This means if you are looking to set up your base station, as well as your take-off and landing positions from a farmer's field or someone else's property, you will need to ensure they give you permission, in writing if possible.

For operations on public property, be familiar with the municipality's by-laws in case there are any restrictions or permit requirements related to the use of RPAS on municipal property such as parks, sidewalks and roadways. A number of municipalities do not allow the

use of RPAS in their parks or public spaces, and they are allowed to restrict the land use in this way. This is separate from the airspace above that land which, as noted above, is managed by NAV CANADA.

TIP! Property owner permission applies to all RPA, not just RPA heavier than 250g! (e.g. This includes all micro drones such as DJI Mavic Mini and some FPV drones)

SHARING AIRSPACE

RPAS pilots must share airspace with other users but not everyone has equal rights to use the airspace. RPAS pilots must give way to all other airspace users such as:

- Helicopters
- Planes
- Balloons
- Gliders
- Paragliders

RPA are highly maneuverable and do not carry living things onboard, therefore they must always leave the airspace by the most efficient method possible if a potential conflict exists. However, you may be able to reduce potential airspace conflicts by increasing your situational awareness, or that of other aircraft, by following these Best Practices:

- Using a handheld aviation radio to monitor air traffic around you and, if you hold an ROC-A, being prepared to use your radio to coordinate with other users in uncontrolled airspace.
- Checking with local low altitude airspace users such as helicopter operators, flight training agencies or flight clubs to find out which users may be in the area and how they normally coordinate with one another.

- Using Visual Observers to increase airspace monitoring.
- Using bright strobe lights to make your RPA more visible. This has the added benefit of also deterring birds in some instances.

CAUTION!
Even if you have had a NOTAM issued for your flight operation you must still give way to all other airspace users.

Aviation Communications

Air Traffic Control (ATC) communicates with pilots in controlled airspace by talking on an aviation radio. Voice communications between aircraft, or aircraft and ground stations, also utilise an aviation radio. Civilian aviation communications uses Very High Frequency (VHF) amplitude modulated radio waves in the frequency range of 118-137mHz. All radio equipment used in Canada must be approved by Innovation, Science and Economical Development Canada (ISED). Formerly known as Industry Canada (IC). Note that there are still many references to “Industry Canada” in many of their documents.

RADIOTELEPHONY

The International Telecommunication Union (ITU) phonetic alphabet is used throughout aviation to ensure clear communications. It is important (and handy!) to be familiar with it.

A – alpha
B – bravo
C – charlie
D – delta
E – echo
F – foxtrot
G – golf
H – hotel
I – india
J – juliet
K – kilo
L – lima
M – mike
N – november
O – oscar
P – papa
Q - quebec
R – romeo
S – sierra
T – tango
U – uniform
V – victor
W – whiskey
X – x-ray
Y – yankee
Z – zulu

TIP! You can practice learning the phonetic alphabet by reading license plates in phonetics when you're in the car.

While it's not necessary for RPAS pilots to hold a Restricted Operator Certificate with Aeronautical Qualification (ROC-A), the knowledge is essential for Advanced Certificate RPAS pilots. This is because you will be operating in airspace where the terminology is used and it will be helpful to understand to improve your situational awareness.
The RIC-21 Study Guide linked in the resources section will be very helpful for your studying and exam.

VHF AVIATION RADIOS

Most traditional aircraft are equipped with VHF aviation radios for voice communications; however, it is not mandatory to have a radio in all types of airspace. An aircraft that is referred to as "NORDO" indicates that it does not have a radio.

While aviation radios in aircraft do not require a station license from ISED, ground stations do require a station license. RPAS pilots who plan on transmitting over aviation frequencies they will need to obtain their Restricted Operators Certificate - Aeronautical (ROC-A). Information on obtaining your ROC-A can be found in ISED's RIC-21 Study Guide. Note that you will be required to take a test with an accredited radio examiner. The knowledge associated with an ROC-A certification is also often taught in TP 15263 compliant ground schools.

CONTROLLED AIRSPACE WITH ATC SERVICES

While aviation radios are invaluable for pilots when coordinating with ATC, RPA pilots are unique in that they are on the ground and not in aircraft; therefore, they do not have radio line-of-sight to ATC.

RPAS pilots should not use an aviation radio to contact ATC under any circumstance unless pre-arranged with ATC. Your handheld aviation radio has good range to aircraft within line-of-sight, but poor range to other ground stations, such as ATC, that are masked by terrain such as buildings and hills. Maintaining a listening watch on the appropriate frequency is always advisable regardless of the fact that you may not be using your radio to transmit. For more information on what the appropriate aviation frequencies are for your flight area, consult the CFS or WAS.

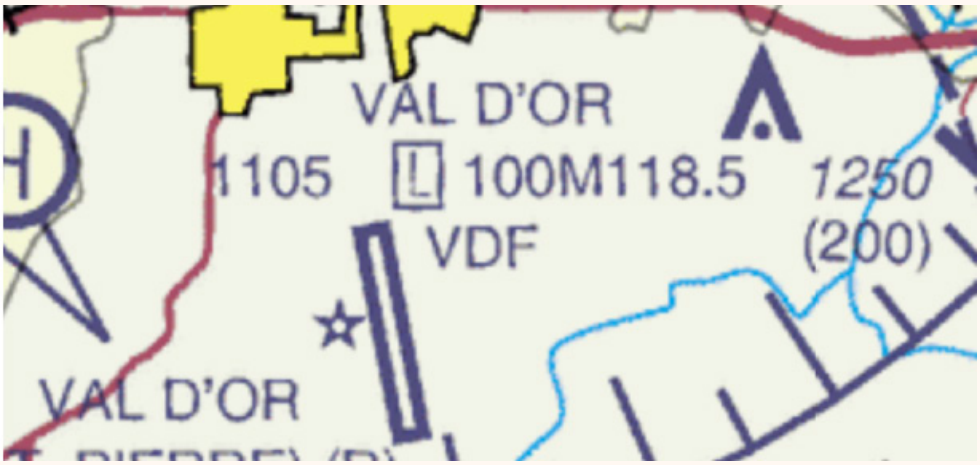
When operating in controlled airspace, your NAV CANADA flight authorization will indicate whether or not communication with ATC is required for your flight and if so, by what method. Regardless of where you are flying, if you need to contact ATC due to an emergency you should use your cellphone and not a handheld aviation radio.

COMM	(bil)
RADIO	118.5 (E) 1030-0325Z‡ (emerg only 819-825-7211)
RCO	Rouyn rdo 118.5 (RAAS) 0325-1030Z‡ Québec rdo 122.375 (FISE) 126.7 (bcst)
MF	rdo 1030-0325Z‡ O/T Rouyn rdo 118.5 5NM 4000 ASL (CAR 602.98)
PAL	Montréal Ctr 125.9 308.3
VDF	118.5 1030-0325Z‡
AWOS	128.15 (English) 120.55 (French) 0325-1030Z‡

TIP! The phone number for the ATC control tower is always listed in the CFS/WAS COMM section for the airport.

USE OF HANDHELD AVIATION VHF RADIOS

If RPAS pilots plan on transmitting over aviation frequencies they will need to obtain their Restricted Operators Certificate - Aeronautical (ROC-A). If RPAS pilots choose to use a handheld aviation radio, there is always an appropriate frequency to be used whether you are



flying in Class G airspace far away from an aerodrome, or flying in a Control Zone surrounding a large airport. Frequencies for specific areas will be shown on VFR Navigation Charts (VNC) or VFR Terminal Area Charts (VTA). If an aerodrome is registered or certified, the appropriate frequency will also be listed in the CFS COMM section under each specific aerodrome.

If there is no specific frequency shown on a chart, the default frequencies are as follows:

- 126.7 for uncontrolled airspace not near an aerodrome
- 123.2 for aerodromes (including water aerodromes) not listing a specific frequency
- 121.5 is the emergency frequency everywhere

TIP! Always check the back side of applicable VTA charts for additional frequency information in dense traffic areas. As there are only 7 VTA charts available for Canada, you can also consult local pilots and flight schools to learn about common practices with regards to frequencies used in the area.

MANDATORY FREQUENCY AREAS

Mandatory Frequency (MF) areas are generally located around moderately busy airports that do not have a control tower but may have mixed IFR and VFR traffic. They are often depicted on aviation charts as Class E control zones but may also be found in un-controlled airspace. They will always have an “M” in the frequency shown on an aviation chart, e.g. M118.5 or will be listed as MF under the COMM. section of the airports CFS listing. The radius of the area covered by the MF will also be listed in the COMM section.

The CARs regulations require all traditional aircraft in MF areas to have a radio and to make radio calls at certain locations as a minimum. For typical multirotor RPAS flights you will not be making runway approaches; therefore, you will not be joining the traffic pattern. Note that some airports have ATC operating with tower (TWR) frequency during the day and then revert to an MF airport at night. If the MF area is in controlled airspace, NAV CANADA will advise you what communications are necessary during the time of your operation. If the MF area is in uncontrolled airspace, you will be responsible for deconflicting with other aircraft. Remember that RPAS pilots must always give way to traditional aircraft.

If there is no tower or advisory service monitoring the airspace, you should, at a minimum, deconflict with any traditional aircraft that are present by making the following radio calls:

- announcing your intentions 5 minutes prior to take off
- throughout your flight when you hear other air traffic on the radio
- after landing announcing that you are down and clear of the air space

TIP! Check the COMM section in the CFS entry for the aerodrome to see if limited operating hours are indicated.

AERODROME TRAFFIC FREQUENCY

Aerodrome Traffic Frequencies (ATF) are used at smaller aerodromes in uncontrolled airspace that are close together and need separate frequencies from the other aerodromes in the area. ATFs are not mandatory and in fact aircraft can operate at or near these aerodromes without a radio. RPAS pilots may follow the same procedures listed above for MF areas if traditional aircraft are present.

The radius of the area covered by the ATF will also be listed in the COMM section of the CFS.

UNCONTROLLED AIRSPACE

In uncontrolled airspace, pilots must communicate with one another to avoid conflicts as ATC is not monitoring the airspace. **An RPAS pilot must always give way to all other aircraft**. An aviation radio can be used to coordinate with other aircraft which may avoid having to leave the airspace in order to deconflict. When operating in uncontrolled airspace, you should maintain a listening watch on the appropriate frequency as indicated on aviation charts (VNC/VTA) or in the CFS. Your response to an imminent aircraft conflict is to move your RPA out of conflict. If you have sufficient time and it is safe to do so, you can make a blind broadcast on the radio that tells other aircraft:

—Which aircraft you are calling (by landmark or aerodrome name)

- Make sure this is specific enough and references something that pilots can easily reference. Check on an aeronautical chart for significant features, towns, aerodromes, VFR checkpoint names nearby, and use cardinal directions

—Who you are

- RPAS do not have callsigns issued so use something like RPAS123 or UAV123 or DRONE123 so that other traditional aircraft know you're an RPAS and so they can call you back.

—What you're doing

- Tell them what height you are operating at (e.g. 200 feet above ground level), what your specific location and operational radius is, and how long you intend on being there.

—How to call you back

- Tell them your callsign again and what frequency you are on as aircraft may be listening to multiple radios and need to know which one to answer you on.

TIP! There is no need to broadcast to any aircraft leaving contrails in their wake

Below is an example of blind broadcast:
"Traffic in the area of [landmark or aerodrome], this is RPAS [identifier] operating at [#] feet AGL and below at [operational radius and location] for the next x minutes. Any conflicting traffic this is RPAS [identifier] on [frequency]"

Aircraft in the area will normally respond by calling you by your identifier and passing on their location, altitude and intent. If there is no potential conflict, you can respond by calling the aircraft callsign and responding that there is no conflict.

TRANSPONDERS

Aircraft including RPA may also communicate with ATC through a transponder that automatically sends data about the flight. A pilot sets a 4 digit code number on their transponder that provides a unique or group identifier to ATC. A mode C transponder is one that also encodes altitude information to aid ATC in managing air traffic. A mode C transponder is required by aircraft operating in Class C airspace and any other airspace that specifically indicates the requirement for a transponder. Small RPAS are not equipped with transponders; therefore, they always need prior authorization to fly in transponder airspace.

Time, Distance and Orientation

24-HOUR TIME

In the world of aviation, time is most often referenced using the 24-hour time clock and Coordinated Universal Time (UTC).
It is important to understand the 24-hour clock as well as time zones as any interaction you may have with NAV CANADA, Transport Canada or other members of the aviation community will likely be communicating in this format.

The 24-hour clock is the convention of time keeping in which the day runs from midnight to midnight and is divided into 24 hours, indicated by the hours passed since midnight, from 0 to 23. In North America we are used to the 12 hour clock and distinguishing morning and afternoon periods by the AM and PM designation. To translate our 12 hour clock to the 24 hour clock simply add 12 to the hour for any time after 12PM. For example 2:30PM becomes 2 +12=14 so it would be 14:30 in 24 hour time. With a bit of practice this will become second nature.

> TIP: Finding it hard to get your brain to think in 24-hour time? Try switching your phone to this format and you'll find it becomes more familiar!

To deal with different time zones, the aviation world bases its reference to time on Coordinated Universal time or UTC. This is sometimes also referred to as GMT but GMT is a time zone much like EST or PST. Thus, in Canada we have our time zones across the country which are noted as UTC-X.

Newfoundland: NST UTC-3.5 / NDT UTC-2.5
Atlantic: AST UTC-4 / ADT UTC-3
Eastern: EST UTC-5 / EDT UTC-4
Central: CST UTC-6 / CDT UTC-5
Mountain: MST UTC-7 / MDT UTC-6
Pacific: PST UTC-8 / PDT UTC-7

TIP! UTC is also referred to as “zulu” which is a carry over from nautical navigation. If you see a time written with a Z at the end, it is referencing UTC or zulu time. Ex. 2100Z Time with an L at the end indicates local time. Ex. 2100L

UNITS OF MEASURE

Aviation uses a number of different units of measure including metres (m), feet (‘), kilometers (km), statute miles (SM), nautical miles (NM), and heights above ground level (AGL) and above sea level (ASL). Canadians have been using the metric system for a long time and as this same population has moved into the RPAS aviation world they are applying what they know.

Traditional Aviation in Canada uses a hybrid of metric and imperial in accordance with international and US models. Some examples:

- Standard Lapse Rate = -2°C per 1000’ elevation gain
- Visibilities are reported in statute miles (SM)
- Altitudes are reported in feet above sea level (ASL)
- Distances are reported in nautical miles (NM)

TIP: Statute miles are the same measurement as a US mile at 5280 feet. A nautical mile is 6078 feet.

Many RPAS are programmed and default to meters and for this reason, CARs Part IX specifies both metric and imperial units.

RPAS operators should become familiar with the use of traditional aviation references, particularly for conversations with NAV CANADA or other organizations that work on both sides of the industry. This consistency in language becomes an issue of safety when RPAS and traditional aviation start to move closer together, sharing similar airspace.

- Altitudes should be referenced in feet AGL (of a location), and advised in feet ASL “We’ll be operating 400’ AGL and below, 3400 ASL on Tree Hill”
- Distances should be referenced in NM whenever possible. Meters and kilometers should not be used.

ORIENTATION

Position of the RPA should be reported with the cardinal directions of North, South, East and West of a reference point. These reference points should be something obvious as viewed from the sky rather than a street intersection or city name.

- South end of Grand Lake
- Northwest of the Port railyard

Remotely Piloted Aircraft Systems

OVERVIEW

Your RPAS is made up of a number of hardware components which are managed and controlled through firmware and software. As the pilot in command (PIC) it is critical that you have a good understanding of all the components, how to maintain them, and understand the capabilities and limitations of your RPAS. This will go a long way in fulfilling your responsibility of ensuring you have a safe, legal and enjoyable experience while using your RPAS.

OPERATIONAL LIMITATIONS

Ensuring a safe flight begins with understanding the operational limitations. Limitations come in many forms: equipment limitations, personal limitations, environmental limitations, and legal limitations. It is the combination of all of these that will help ensure your safety and the safety of others.

REGISTRATION

All RPA 250g and up to 25kg must be registered with Transport Canada and clearly marked with the provided registration number. This is similar to cars and trailers requiring a license plate. Registration takes place in Transport Canada's Drone Management Portal and costs $5 for each registration. You are also able to de-register your RPA through the same portal.

An RPA registration number begins with a "C" and is followed by a 10-digit number, the first two indicating the year of registration. Marking the drone with the registration number can be done with a

pen, engraver or label so long as it is affixed to the RPA itself and not a battery or other removable component.

Certificates of Registration must be carried on site during operations and do not expire. They can be cancelled under several conditions:

- the aircraft is destroyed;
- the aircraft is permanently withdrawn from use;
- the aircraft is missing and the search for the aircraft is terminated;
- the aircraft has been missing for 60 days or more;
- the registered owner has transferred legal custody and control of the aircraft;
- a registered owner of the aircraft dies;
- an entity that is a registered owner of the aircraft is wound up, dissolved or amalgamated with another entity; or
- a registered owner ceases to be qualified to be a registered owner.

Under any of these conditions listed above, Transport Canada must be notified within 7 days of a change taking place.

SAFETY ASSURANCE

The Safety Assurance system for RPAS, is based on a manufacturer's declaration that their RPAS meets one or more of the standards set out in Standard 922, and allows pilots to operate in one or more of the following environments:

- operations in controlled airspace;
- operations at a distance of less than 100 feet (30 m) but not less than 16.4 feet (5 m) from another person except from a crew member or other person involved in the operation, measured horizontally and at any altitude; or
- operations at a distance of less than 16.4 feet (5 m) from another person, measured horizontally and at any altitude.

MAINTENANCE

The manufacturer of your RPAS must specify a maintenance program including instructions on how to inspect, service and maintain your system including the intervals at which to do so and any mandatory actions that must take place.

Since you must abide by the instructions of the manufacturer, these maintenance requirements must be worked into your process and procedures. Unlike a car, there is not a whole lot of maintenance that can be done to most small RPAS but inspections for wear and tear are routine. If anything is cracked, frayed, chipped, or warped it should be repaired in accordance with manufacturer instructions prior to flight.

Some maintenance work will need to be done by an authorized repair facility or the warranty of your RPAS will be compromised. Be sure to read any maintenance directives carefully and refer to professionals whenever necessary.

Refer to the Certificates and Manuals section for information on maintenance manual retention requirements.

SYSTEMS

Your RPAS is a sophisticated device, composed of a series of physical, mechanical and electrical components enabling it to operate. It is not necessary for an RPAS pilot to fully understand every component and the inner workings. However, a basic understanding of the systems and their operation will make for a better and safer pilot.

Tip! Read the manual that came with your RPAS, it will contain a lot of very important information on how to handle, operate and maintain your RPAS and contains operating limits and restrictions.

PROPULSION/LIFT

An RPA is able to operate above the ground due to lift. Lift relies on smooth air flowing over an aerofoil shape.

Fixed wing RPA generate lift through the use of stationary aerofoils (wings) as the unit is propelled forward by either a combustion engine, electric motor or a combination of both (also referred to as a hybrid). Multirotor and helicopter RPA generate lift from rotors which are, in effect, rotating wings. In this case, motors spin the wing directly. Multirotor RPA units come in various configurations with the most common being a quadcopter, meaning it has 4 propellers.

Note! Vertical Take Off and Landing (VTOL) fixed wings are becoming more popular as they take advantage of the fixed-wing efficiency with multirotor launch and recovery footprint!

ELECTRIC MOTORS

Brushless DC electric motors have been instrumental in the development of multirotors. They are very efficient and use much less power than traditional brushed motors. Even more importantly, they are very responsive and can change speed instantly based on the Electronic Speed Controller's output.

Motors can be "in runner" or "out runner" named for the part of the motor that spins with the propeller or rotor. Brushless out runner motors are most popular on RPA. The outside bell of the motor spins and allows for very secure attachment of the propeller or rotors. In runner motors generate more heat but can spin much faster with less energy used than out runners.

> TIP! Did you know that you can calculate the maximum RPM of a DC brushless motor by multiplying the motor's Kv rating by the battery voltage?

Other Propulsion Types

Rarely, you may encounter gas powered RPA using either a small piston-driven or jet powered engine. Typically, these systems are reserved for RPA above 25kg and/or flying BVLOS and require much more maintenance, training and safety practices to ensure their safe operation.

Navigation

For fixed-wing RPA, control is maintained through a combination of propulsion for the thrust, and movement of control surfaces such as ailerons, elevators and rudder for axial control. It is the precise coordination of all of these components that enables the pilot to fly fixed wing RPA in a controlled manner. One limitation of a fixed wing RPA is that it cannot hover. The pilot must constantly ensure they are aware of the flight path of their RPA and there is a greater emphasis on the pilots flying skills and automation for control.

Multirotor RPA control both lift and the direction of flight by varying the speed of the individual motors. Multirotors are reliant on sensors for stability and to coordinate the change in motor speeds in response to inputs given by the pilot. While a high degree of coordination is still required, multirotors can be easier to control and they have the ability to hover.

SENSORS AND ELECTRONICS

Today's RPAS units contain advanced electronics and sensors. It is the relative recent advancement and commoditization in these components that has enabled the growth in and demand for RPAS units.

Flight Controller

The flight controller is the brains of your RPAS. It is essentially a very small yet powerful computer that controls most of the systems on your RPA. It is responsible for coordinating the vast amount of information it gets from various sources such as sensors, the pilot, and other electronic components, and translating that instantaneously into instructions, which are relayed to the ESCs to maintain controlled and stable flight. Many flight controllers can also be programmed or adjusted to allow, for example, more aggressive flying styles, faster in-air braking or smoother and slower movements are commanded by the pilot.

Electronic Speed Controller (ESC)

An ESC is an electronic device that is able to control and quickly change the speed and torque of a DC brushless electric motor. By precisely modulating the 3 power leads to each motor, the direction of the RPA can be changed and accurately controlled. As an example, by increasing the speed of the back propellers, the RPA will move in the forward direction.

Inertial Measurement Unit (IMU)

The inertial measurement unit is a very sensitive sensor that is able to quickly and accurately measure movement. It gathers information about the aircraft's orientation and angular movement about

three axes, relaying that information to the flight controller to enable your RPAS to operate in a controlled manner. Movement during the calibration phase of the IMU can cause misreading throughout flight. While your aircraft is powering on, leave it on a flat surface and do not pick up or adjust it until the initialization is complete.

GNSS

Global Navigation Satellite Systems such as the Global Positioning System (GPS) are now found in almost all RPAS. Just as in a car, the GPS in your RPAS provides the pilot with a wealth of information including accurate location (coordinates), speed and direction of travel. A minimum of 4 satellites are required for this information but most manufacturers will suggest a minimum of 7 prior to launch. Some RPAS units are able to use this information for additional purposes such as accurate mapping and camera control. In northern latitudes, systems may not receive as many satellites due to the orbits of satellites being concentrated in southern latitudes. They may also have more positional error due to the longer radio paths through the earth's ionosphere that can delay the signal. Masking can occur at any latitude when terrain blocks the signal from the satellites. This can reduce accuracy or the RPAS may lose satellite signals completely.

For more accurate locating, systems that enhance GPS location such as Differential GPS (DGPS) or Real Time Kinematic (RTK) systems can be used. Through the use of a ground station at a fixed point, DGPS increases GPS accuracy from approximately 15 metres to about 10 centimetres. RTK systems can have 1 centimetre accuracy.

Magnetometer/Compass

Many RPAS units also have a magnetometer. This is a basic but vital sensor as it tells the system in which direction it is pointed much like a compass. When this directional information is combined with GPS information, the RPAS has a very accurate and complete understanding of its orientation and place in space. Your RPAS may

require a special procedure in order to calibrate your magnetometer for your location due to variances in earth's magnetic field.

Local disturbances in the earth's magnetic field called magnetic deviations (not to be confused with magnetic declination/variation) can interfere with your compass. These disturbances can be caused by naturally occurring objects such as iron-rich rocks, or they can originate from magnetic metals or electrical equipment nearby or underground.

If you receive a message to calibrate your compass on your RPAS controller, you should first move the RPA to another area that is fairly certain to be free from metallic objects (such as over to a grassy area away from cars and hard surfaces that may have rebar) to see if the message goes away. If you recalibrate your compass in an area that has a magnetic disturbance, it will calibrate to the anomaly and look fine; however, once you take off and move away from that area you will have issues with the RPA maintaining a heading or moving to a GPS waypoint. Below is a general guideline for safe calibration ranges:

- Small metal objects like rebar -2m
- Larger objects like vehicles -15m
- High-tension powerlines -55m

> TIP! Check your manufacturer's manual for procedures applicable to calibrating your RPA compass.

Barometer

Your RPAS may also have a barometer on board as part of its sensor package. The critical role of the barometer is to provide information on altitude. It does this by accurately measuring the air pressure which is then translated into a measurement above ground. RPAS barometers zero themselves when they take off

therefore, height indicated on your RPAS controller will always be relative to your take-off location.

PAYLOADS

The payload of your RPA is anything over and above what is required for it to fly. It is typically the reason why you're flying! The most common payload is a visual (RGB) camera. In addition to RGB cameras which are used to capture video and still photos, there is an ever increasing list of RPA payload options. To name a few, this list includes:

- LiDAR used for accurate laser measurements and mapping,
- Multi-spectral and hyper-spectral cameras,
- Thermal (infrared) cameras to detect variations in temperature,
- Cargo.

GROUND STATION

The ground station is what allows the RPAS operator to give direction and instruction to the RPA. The most common form is a handheld device that has control sticks and buttons which allow the pilot to send instructions to the RPA. Other options include computers such as a laptop or handheld electronic devices that can be used to program and command flight instructions to the RPA. An RPA can also have multiple components to the ground station. For example, one operator can control the RPA itself, and another operator can control the payload. It is important for the operator to be fully familiar with the functions of their ground station as this is the primary means in which they ensure the safety of the RPA.

LAUNCH AND RECOVERY

There are some RPA units which require additional components to assist them in becoming airborne (quick acceleration) and to land (quick deceleration). These launch and recovery systems are typically unique to the RPA and require additional handling, training and operating procedures to ensure their safe operation.

A common launcher is an inclined ramp powered by elastics, springs or pneumatics. They require extra care and special attention to their operating limitations as elastics, for example, can become brittle in cold temperatures. Recovery options include a belly landing, deep stall, hand catch or nets and wires that act as arresting cables, enabling the RPA to land in a smaller footprint.

Follow manufacturer guidelines for use of launch and recovery systems including hand launching and catching.

BATTERIES

While some RPA may have internal combustion engines, it is likely that batteries will still provide power to the sensors and payload. In other systems, they may be required for everything to operate. It is the advancement in battery technology that has led to the proliferation of the use of RPAS and remains one of the limiting technologies in their continued growth.

Today's batteries have enough capacity to store electricity to power all the systems, and as with "smart batteries", have built in computers to manage and monitor their performance.
Lithium Polymer (LiPo) batteries are integral to RPAS due to their high efficiency by size and weight. They are able to provide more power (4.25 V) in a smaller and lighter package than other batteries. Batteries, however, pose a risk to users and others if they are not safely charged, used, managed and stored.

In addition to having methods available to extinguish potential fires caused by a battery, reduce the risk of fire and failure through the following practices:

- Do not charge batteries unattended,
- Do not store or charge near any flammable materials,
- Do not allow your batteries to get colder than -10°C,

- Keep your batteries above 15°c prior to flight by storing them in a warm vehicle or inside your jacket on cold days,
- If a battery has been dropped or impacted, isolate and watch for swelling,
- Do not use a swollen battery,
- Dispose of batteries properly,
- Allow batteries to cool to the touch before charging,
- Keep batteries out of the sun,
- Abide by all manufacturer guidelines.

Always be aware of the level of charge in all the batteries required for the entire RPAS. This includes main batteries, sensor batteries, controller batteries, and screen/tablet batteries.

How to be a Better Pilot

before you even leave the ground

YOUR RPAS MAY BE EASY TO FLY... BUT IT IS HARD TO FLY WELL!

READ THE MANUAL

Now that you have a good understanding of the RPA and its general systems, a good way to take your knowledge to the next level is to put it into practice. Now is a good time to do a thorough read of the manuals that accompany your specific aircraft model. If you happened to have discarded these documents like IKEA instructions, most manufacturers also have most recent editions available on their website.

Manufacturers are required by law through CAR 901.78 to provide an operating manual for their RPAS including limitations, system specific descriptions and procedural guidance. Not only is this aircraft-specific knowledge essential for pilots to be familiar with, it will help you to structure the SOP documents that are required for both Basic and Advanced pilots.

TIP! When on site, ensure the operating manual is easily accessible at all times—either printed or on a device *other than the one you're flying with!*

THERE'S AN APP FOR THAT

Reading about the systems, functions and tools your RPAS provides in the manual is one thing. Learning how to proficiently access them is another! Most control stations will provide you with many telemetry items that are useful for managing the aircraft's flight. You'll want to, over time, develop a familiarity with the location of this information on your control station screen so you're able to access and retain the information you need with just a quick glance.

Building this familiarity will come from practice. Many RPAS will allow you to access the control station app functions while the aircraft is powered on, even if it remains on the ground. This will allow you to safely click through menus, change settings and adjust modes to your preference - all without spinning a prop! When it is time to fly, you'll have the foundation and confidence to take advantage of all your RPAS has to offer.

If applicable for your RPAS, ensure you know how to:

- Start and stop motors
- Set RTH parameters
- Activate RTH
- Cancel RTH once activated
- Do an emergency motor shut-off
- Activate other flight termination systems
- Identify altitude
- Identify distance from the pilot
- Identify number and strength of GPS satellite signals
- Change flight modes
- Activate and deactivate sensors
- Turn on and off the lights
- Adjust payload/sensor parameters
- Calibrate the compass

PERFECT PRACTICE MAKES PERFECT

When it comes time to fly, there's no such thing as arriving and "just popping up quickly". You will have gone through the effort at this point to build procedures. Use them. Every. Single. Time.

Not only does this make good your checklist building, but doing things the same way every time builds muscle memory and helps to limit mistakes. It's not just practice that makes perfect, it's perfect practice that makes perfect. And eventually your ability to complete a site survey and your normal procedures will be efficient and second nature. If you're pursuing an Advanced Certification, take advantage of the Basic Certificate you'll be issued once you successfully complete your Advanced written exam. Get out and practice your SOPs before your flight review. You definitely don't want your first pass through your SOP to be in front of a reviewer!

TIP! Pick up some inexpensive cones and set them up for practice flights. Practice orientation control as you fly different patterns around the cones. Work toward stopping accurately on a point, changing altitude as you travel and run through your emergency procedures regularly too.

The Environment—Weather to Fly or Not

RPAS are often used in demanding environments. In order to ensure safe operations you should always operate your RPAS within the limits stated by your SOPs and the manufacturer's specifications with respect to:

- Temperature range,
- Moisture (rain, icing, fog),
- Dust,
- Wind speeds.

You should also be aware of the effects of atmospheric pressure changes on your aircraft.

> Tip: Don't forget that the environment also has an impact on the crew and control stations too!

Every RPAS model has its own rating when it comes to operations in varying environmental conditions. Your RPAS manufacturer will normally indicate the environmental ratings of your aircraft in your manual. If they are not indicated, you should check with the manufacturer to what the ratings are.

TEMPERATURE

Temperature is a limiting factor in the operational control of RPAS. Most, if not all RPA under 25kg operate using Lithium Polymer (LiPo) batteries which are sensitive to extreme temperatures. Very cold temperatures limit operating time while hot temperatures can cause damage and erratic power supply.
Manufacturers of RPAS place temperature operating limits on their systems. These limits protect the operating integrity of the systems and RPAS operators are required by the CARs to not exceed manufacturer's operating limitations.

In extreme cold temperatures, pilots of RPAS are challenged with the ability to adequately control RPAS due to limitations on physical endurance and finger dexterity.

Temperature in earth's atmosphere decreases as you get higher. The approximate drop in temperature is 2°c per 1000' of altitude gained.

PRESSURE

Atmospheric pressure is a result of heating and cooling of the earth's surface. Heating and cooling causes either high or low pressure areas. Pressure difference is also a function of elevation. The higher you go into the atmosphere, the less dense the air becomes and therefore, there is less atmospheric pressure. As a general rule, atmospheric pressure drops approximately 1 inHg per 1000' of altitude increase.

This is an important fact to remember when operating RPAS at higher elevations. As you ascend, the pressure drop will result in decreased RPA performance. Higher battery consumption will result, and shorter flight durations can be expected. Check your RPAS manufacturer's manual for altitude limits.

AIR MASSES AND FRONTS

Air masses are larger sections of the atmosphere that contain air of a similar temperature and moisture content. Areas over the earth's oceans will be cooler and more humid than air above a desert area or frozen surface. A "Front" is the line along the earth's surface where two air masses meet. Fronts are described as warm or cold depending on the relative temperature of the advancing air mass.

Weather fronts are associated with low pressure systems as air converges into the low pressure region and twists the air masses together. This is due to the Coriolis Effect. A warm front will always proceed a cold front as a low pressure system approaches. Warm fronts ride up over top of cooler air and form high clouds initially. Cold fronts slide underneath warmer air and create unstable air by forcing the warm air upwards.

SUN

You may think that sun equals perfect flying days but the sun can present unique challenges to the operation of RPAS!

On cloudless or thin overcast days the sun can, in effect, act as an obstacle. If your flight requires you to face the sun, you can easily lose sight of your RPA - particularly if you aren't equipped with effective glasses and other gear. It's good practice to note where the sun is prior to flight and set up your site accordingly.

Be aware of how being exposed to the sun for extended periods of time can negatively affect you and your crew as well. Regardless of outside air temperature, the sun is dehydrating. Ensure you have access to shade, water, head protection and eyewear.

Screens are often integrated into or attached to the control stations of RPAS. On bright days, screens become challenging to read. Non-purpose built screens such as consumer tablets may require a sun shade to be useful outdoors. RPAS-specific devices or integrated screens are typically brighter to deal with bright, outdoor conditions.

STABILITY/INSTABILITY

An airmass will be termed unstable when warm air at lower levels rises. For example, a warm air parcel will want to rise into cooler air above it. If it continues to be warmer than the surrounding air it will expand and cool. Any moisture that was suspended in the warm air will become visible in the form of clouds as the air cools and condenses, becoming saturated, and eventually precipitation will follow. Unstable air is associated with turbulence, tall, billowing cumulus clouds and can eventually lead to thunderstorms.

Stable air occurs when air is cooled from below. Being cooler than the air above it, the air will not rise and will remain in place creating stable conditions such as stratus cloud and calm air.

WIND

Most RPAS manufacturers will specify the wind speed limitations that you must abide by. Not only does this keep your RPA safe, but operating within the manufacturer's limitations is required by the CARs.

Wind makes it challenging for your RPA to maintain position, which in turn causes it to deplete the battery faster than typical. A tailwind can give your RPA fantastic groundspeed, but be aware that on the return trip, it becomes a headwind. This is not something you want to be fighting as the low battery sound turns on!

Wind also affects the pilot and crew. Temperatures feel colder when there is wind, particularly on exposed areas such as fingers. These chills can not only be distracting, but can cause a lack of required dexterity for maneuvering your RPAS.

Be mindful of the effects of wind on yourself and your RPAS and be wary of gusty conditions and environments that are conducive to unpredictable wind patterns such as:

- Shorelines
- Mountainous terrain
- Narrowed passages between buildings or stands of trees

MOISTURE

RPAS ratings can range from zero tolerance for rain to being able to operate in monsoon conditions. If your RPAS manual indicates a rating in the format IP65, it indicates that Ingress Protection testing has been done for tolerance to dust and water. The first number is the solids particle size tolerance and the second number is the water tolerance level. The following can be used as a guideline for IP:

- IP62 can be operated in light rain,
- IP63 can be operated in moderate to heavy rain,
- IP64 can be operated in very heavy rain and areas where the unit is exposed to splashing,
- IP65, IP66 and IP67 can be considered as “weatherproof” and can handle any type of rain.

Be aware that your RPA may be rated differently than your payload. Camera gimbals are often affected by rain and your camera lens can also be covered by water droplets making photos and video unuseable. If you notice erratic behaviour in your RPAS, return to land immediately.

If you fly your non-waterproof rated RPAS in the rain, always make sure to keep your RPAS covered for as long as possible prior to take-off and back to a covered area as soon as possible after landing.

CAUTION! - Completely dry all of your RPAS components after completion of your flights and keep all of the components in an area with a free flow of air until it is completely dry. Even if your RPAS is waterproof, corrosion can damage your RPAS if it is put away while still wet.

Remember there are other components that may need to be rated for wet environments protected if they are not rated for rain. Some other items to consider are:

- The control station,
- The display device (smartphone or tablet),
- Your crew!

FOG

Fog is essentially a cloud that forms on or very near to the ground. Like clouds, it forms when air is cooled to the point of saturation and visible moisture appears. There are many types of fog - steam fog, advection fog or radiation fog – and they are named by the cooling influence. For example, radiation fog occurs on a clear spring or fall night when the earth cools, radiating heat back into the atmosphere and enabling the air just above the surface to reach its dew point.

ICE

Under icing conditions, ice can build up extremely quickly on RPA rotors or propellers and wings. Icing on these critical surfaces can have disastrous effects on the ability to control the RPA or even keep it airborne.

Ice can have the following negative effects on an RPA:

- Increased weight,
- Reduction of lift by interfering with the smooth airflow that airfoils need over their surface,
- Increased drag.

The majority of RPA do not carry de-icing equipment and therefore are not permitted to fly:

- with any ice or snow on the aircraft;
- into known icing conditions; or
- into forecasted icing conditions.

TIP! Critical surfaces on an aircraft are any surfaces that contribute to lift or are in the downwash of a lifting surface. These are particularly sensitive to icing conditions and must remain clear of any contaminants for safe flight.

What are known and forecasted icing conditions?

- If you see visible moisture (clouds or fog) forming at the altitude you will be operating and the temperature is zero degrees or less you are in known icing conditions.
- If the difference between temperature and dew point is 3 degrees or less, the temperature trend is falling and the temperature is zero or below, you can anticipate icing.

CAUTION! water droplets in fog or cloud or freezing rain can be supercooled to below zero and can freeze and adhere on contact to propellers, rotors and wings.

THUNDERSTORMS

Thunderstorms represent some of the most dangerous and unsettled weather conditions. It is essential to be aware if there are thunderstorms nearby. While you may not be experiencing out-of-limits weather or severe conditions in your location, storms can move quickly and some of their impacts can extend far beyond their core. You should avoid flying if there is a thunderstorm within 15NM of your location. The gust front due to downbursts and microbursts in storm cells cause strong, damaging winds. You can anticipate nearly all weather hazards to aviation including rain, hail, sudden darkening, lighting and thunder, all of which can have major impacts on your flight as well as your safety.

WEATHER RESOURCES

Being aware of the weather conditions in and around your flying location is one of your key responsibilities as an RPAS pilot. Ultimately you are the person that has to decide whether you can safely operate your equipment under the prevailing conditions. Weather can be quite unpredictable and so it is important for you to:

- have accurate and current information on hand to make your decision,

- monitor the weather trends in the days leading up to your flight and on the day of the flight,
- have a full appreciation of what to expect so that both you and your equipment are appropriately prepared.

There are many weather resources available to you. NAV CANADA offers a number of official aviation weather resources on their website and through their planning services.

Having a reliable weather app on your phone can help you easily monitor conditions while on site.

> TIP! WeatherCan is an app offered by Environment Canada and Windy is a third party app that can be tailored to report on the weather parameters most relevant to your situation.

The best weather predictor will be you, once you are on site. Always be aware of the conditions, the normal weather patterns in the area, and be on the lookout for changes coming your way.

Dealing With Emergencies

99% of the time while operating your RPAS you will be having fun or at least achieving your business objectives. However, being prepared for emergencies is an important and key component of being able to operate your RPAS safely.

Emergencies can arise for any number of reasons (incident or accident) but will generally fall into one of three categories: Equipment, crew, or environment. It is important to pre-consider the various emergency scenarios you could potentially face and think through what you would need to do and how you would respond.

The fundamental steps in dealing with any emergency include:

1. Quickly assessing the nature of the emergency
2. Identifying immediate actions required
3. Responding to immediate risks and problems
4. Getting control of the situation
5. Identifying and responding to less critical elements related to the emergency.
6. Documenting and reporting
7. Addressing any fixes or changes required in order to return to normal operation in the future.

As per the regulations in 901.23, you must have emergency procedures in place for the following emergency situations:
(i) a control station failure,
(ii) an equipment failure,
(iii) a failure of the remotely piloted aircraft,

(iv) a loss of the command and control link,
(v) a fly-away, and
(vi) flight termination.

While the specific steps required in these emergency scenarios are highly aircraft and operation dependent, listed below are some recommendations to consider in the creation of your checklists. In no way should this be considered a comprehensive list or complete action plan.

CONTROL STATION FAILURE

Whether controlled via a laptop, remote controller or other device, the RPAS crew should have troubleshooting items committed to memory for immediate action in the event of a control station failure. Pilots must know, and practice for situations to understand how their aircraft will respond to a crashed app, powered down transmitter or an unplugged antenna or device.

EQUIPMENT FAILURE

Equipment required varies by RPAS but can include items such as parachute systems, launch and recovery systems or standalone antennae. While some equipment will not be flight-critical, crews must know what items require aircraft grounding and which are safe to fly without. Establishing a manufacturer-advised minimum equipment list is a good practice.

Some RPAS will not have much in the way of “equipment” that wouldn’t be addressed under other emergency procedures. Instead, these pilots might make a list of items required for safe flight.

FAILURE OF THE RPA

Erratic or unexpected behaviour from your RPAS requires troubleshooting. Crews should be aware of items that will cause a critical failure of the RPA and what flight condition these failures will create.

While fixed wings may glide, most multirotors and helicopters will descend with varying levels of control. Immediate actions should involve establishing a safe area and preparing for injury or incident response.

Battery Failure

Battery failures can be one of the most dangerous failures. RPAS batteries are advanced in their design so they can deliver a lot of current consistently. However, when nearing the end of their charge, the power provided drops off very suddenly. Battery failure can occur not only while in use, but while it is being charged. Follow your manufacturers instructions when handling and charging your batteries and whenever possible, confirm the battery health prior to flight. Misuse or incorrect charging can lead to battery failure or fire. A battery failure while flying will often result in loss of control of the RPAS as it is critical for keeping your RPAS in the air. A checklist is recommended to provide guidance in the event of a fire or impact.

LOSS OF THE COMMAND AND CONTROL LINK

A lost link is when the connection between your controller and the RPA is compromised. Your RPA may respond unreliably or not at all to commands you send it. Immediate action items should include troubleshooting which, depending on the system used, may involve reorienting antennas, confirming or exchanging the cable connection or selecting a flight termination system. Crew should monitor the aircraft and the airspace until the connection can be regained, the aircraft lands safely or fly away procedures should be commenced. Many RPA units have a “return to home” feature which can either be manually activated or in some cases will automatically engage after a defined period of time of losing a link. If the RPAS does not react in the expected manner when a lost link occurs, it is important to take note of where the RPA is, what direction it is heading, and how much battery was left. Lost link scenarios can evolve into a fly-away emergency. It is very important that you fully understand how to configure these settings for the environment you are flying in and understand how these features work for your specific equipment.

FLY-AWAY

A fly-away indicates an unresponsive aircraft that is uncontrollable, departing the flight area in a horizontal or vertical direction and requires immediate action by the crew to mitigate associated risks both in airspace and on the ground.

After initial troubleshooting, action should be taken to alert the airspace authority of a deviation from the planned flight path and any potential conflicts that may exist. It is critical pilots understand the airspace surrounding their operating environment both laterally and vertically in the event of a scenario such as this. A flight termination action may be warranted in the case of a fly-away due to the potential danger to people and aircraft.

FLIGHT TERMINATION

Flight termination can take many forms and may be as simple as an immediate normal landing, motor cut off mid-flight, or as complex as a fragmentation system or parachute. Another common flight termination system is the return-to-home or RTH feature. In the case where the aircraft is flying erratically and you still have a command link with the RPA, you may also be able to initiate a command to shut the motors down (e.g. using the combined stick command or CSC). Crews should know when and how to activate the flight termination options and how to cancel or override them, if possible.

LOSS OF VISUAL LINE OF SIGHT

In the event you lose sight of your RPA, there are a few things you can do to regain visual sight of it.

- Try to enter a holding pattern,
  On a multi rotor this could mean hovering and many fixed wing offer a position hold function
- Slowly increase altitude to reduce background distractions,
- If your monitor is still functioning, information on the display will help you identify:

—where the RPA is relative to your position
—what direction it is facing
—RPA height
—RPA speed

If this information does not help you regain sight of your RPA you can try

- looking slightly away from its presumed direction and move the RPA left and right or up and down. Your peripheral vision may detect it.
- yawing the RPA. The movement of the lights might be enough for you to re-acquire visual sight and orientation of your drone.

In the event you are still not able to regain visual sight another option may be to manually activate the return to home function of your RPAS.

Note: it is very important to be fully familiar with how the return to home function works on your RPAS and you know what the settings are. This will determine how fast, how high and where it will return to

AFTER THE EMERGENCY

While your focus will be on dealing with the emergency at the time it is happening, it will be equally as important to work through a number of steps once the immediate situation is over. Depending on the nature of the incident, there will likely be various forms of communication required to update impacted or involved parties. It is your responsibility as the pilot in command to ensure all incidents are appropriately responded to. The sections below will provide further guidance.

EMERGENCY CONTACTS

During an emergency where you are unable to control your RPA or terminate its flight, you must mitigate the risk to other aircraft as quickly as possible. Depending on whether you are in, or close to, controlled airspace or in an isolated area far from controlled airspace you may have to contact someone to help keep other aircraft safe. Here are some general guidelines:

In or near a control zone with ATC

- Contact the tower emergency number listed in the CFS under the COMM section for the nearest airport that is currently staffed. (watch for limited hours)

In controlled airspace other than a control zone (above or adjacent to you)

- Contact the Area Control Centre (ACC) Shift Manager for the Flight Information Region you are in.

In uncontrolled airspace not within range of controlled airspace

- Use your aviation radio to alert other aircraft in the area
- Contact the Area Control Centre (ACC) Shift Manager for the Flight Information Region you are in.

FIR ACC EMERGENCY CONTACTS 24/7

GANDER ACC
Shift Manager
Telephone: (709) 651-5207
Email: QXACCSHIFTMNGRS@navcanada.ca

ACC Operations - Area Control Centre
Gander International Airport
Memorial Drive
P.O. Box 328
Gander, NF A1V 1W7

WINNIPEG ACC
Shift Manager
Telephone: (204)983-8338
Email: wpgaccsm@navcanada.ca

ACC Operations - Area Control Centre
Winnipeg International Airport
777 Moray Street
Winnipeg, MB R3J 3W8

MONCTON ACC
Shift Manager
Telephone: (506) 867-7173
Email: yqmga_YQMShiftman@navcanada.ca

ACC Operations - Area Control Centre
Moncton International Airport
222 Old Coach Road
Riverview, NB E1B 4G2

EDMONTON ACC
Shift Manager
Telephone: (780) 890-8390
Email: SM_Edm_Shft_Mgr@navcanada.ca

ACC Operations - Area Control Centre
Edmonton International Airport
P.O. Box 9867
Edmonton, AB T5J 2T2

MONTREAL ACC
Shift Manager
Telephone: (514) 633-3365
Email: REAquebec@navcanada.ca

ACC Operations - Area Control Centre
Dorval International Airport
1750 Chemin St. François
Dorval, QB H4P 2P6

VANCOUVER ACC
Shift Manager
Telephone: (604) 586-4500
Email: vrsm@navcanada.ca

ACC Operations Area - Control Centre
7421-135th Street
Surrey, BC V3W 0M8

TORONTO ACC - TMU EAST
Telephone:
(800) 268-4831 (Canada)
(800) 387-3801 (US)
FAX: (905) 676-3121
Email: tmueast@navcanada.ca

INCIDENT AND ACCIDENT REPORTING

Transport Canada

As per CAR 901.49, no accidents or incidents are required to be reported to Transport Canada; however, certain accidents and incidents require you to:

- Cease operations,
- Analyze what caused the accident,
- Implement corrective actions to prevent reoccurrence,
- Keep a record of the analysis on file for a period of 12 months and present it to Transport Canada upon request.

Note: If any incident or accident occurs while an RPA is being operated under a SFOC-RPAS, it shall be reported to TC using the RPAS Aviation Occurrence Reporting Form sent with the issuance of the SFOC-RPAS.

> TIP: Don't forget that a missing RPAS will require you to deregister within 7 days

The following scenarios are considered incidents for the purposes of this section.

- injuries to any person requiring medical attention;
- unintended contact between the aircraft and persons;
- unanticipated damage incurred to the airframe, control station, payload or command and control links that adversely affects the performance or flight characteristics of the aircraft;
- any time the aircraft is not kept within horizontal boundaries or altitude limits;
- any collision with or risk of collision with another aircraft;
- any time the aircraft becomes uncontrollable, experiences a fly-away or is missing; and
- any incident not referred to in paragraphs above for which a police report has been filed or for which a Civil Aviation Daily Occurrence Report has resulted.

Transportation Safety Board

While Transport Canada only requires you to record certain RPAS incidents and accidents, the Transportation Safety Board (TSB) has their own regulations and reporting requirements.

The following accidents involving the operation of an RPAS are reportable to the TSB:

- an RPA weighing more than 25 kg is involved in an accident, as defined by paragraph 2(1)(a) of the TSB Regulations; or
- a person is killed or sustains a serious injury as a result of coming into direct contact with any part of a small RPA (an aircraft with a maximum take-off weight of at least 250 g [0.55 lb] but not more than 25 kg [55 lb]), including parts that have become detached from the small RPA; or
- a collision occurs between an RPA of any size or weight and a traditional aircraft.

Reporting must be made ASAP after the incident to a TSB investigator 24/7 by phone at:

1-800-387-3557

The investigator will advise if a full report is to be submitted within 30 days.

See the TSB website Report an Aviation Occurrence for more information.

Human Factors

Human Factors represent a large and varied source of risk when it comes to operating your RPAS. Many of the factors listed are not only relevant to RPAS use but also to many day-to-day interactions at home or at work. For more detail on any of the topics discussed below, check out the resources section.

CREW MANAGEMENT

Crew Resource Management (CRM) is a function of lessons learned over the years in aviation through the investigation of accidents and incidents. Breakdown in communications among crew members was found to be a common contributing cause of these accidents. When operating your RPAS, avoiding communication issues amongst crew is the responsibility of all crew members on site.

As the RPAS Pilot (PIC- Pilot in Command) you are ultimately responsible for the safe operation of the RPAS in all phases of flight. Not only are you responsible for flying safely, but you need to be able to take in and process information related to all aspects of the operation to ensure the safety of the flight and those on the ground. This is referred to as Crew Management (CRM).

There are three fundamentals to successful CRM:

- Seeking information,
- Stating one's position,
- Active listening.

Seeking Information
It is critical to be comfortable with asking questions. Good decisions are based on good information. When in doubt, asking questions provides the information flow which can prove vital in avoiding a hazardous situation.

There can be a reluctance within crews to ask questions or question an instruction that has been given. The PIC is ultimately responsible for the RPAS operation but it is every crew members' responsibility to understand their role, provide information and to follow the directions of the PIC. RPAS crew need to be aware of these potential challenges in sharing information and together, understand the importance of open, clear and direct communications.

Stating One's Position
When operating a RPAS, all crew members should be fully briefed on all aspects of the flight. This includes identifying the roles and responsibilities of each crew member as well as clients or other personnel on site. Part of any briefing must include direction to the crew that it is acceptable and important to question or inform the pilot of any abnormal situations that could affect the safety of the flight. Failure to do so can lead to a lack of communication amongst crew members and potentially lead to serious situations or injury.

All opinions the crew members present need to be valued and considered as part of any decision making process. Crew members must be encouraged to follow this process in order to share information and prevent potential problems. Having a respectful two-way communication policy will build confidence and strengthen crew teamwork.

Crews should be trained to ensure that their concerns and comments are communicated clearly and effectively. The following steps have proved useful in assisting this process:

- Make sure you get the attention of the person who needs to hear your concern,
- Share your concern clearly and concisely,

- State the problem clearly and concisely,
- Offer a suggestion or solution to the situation,
- Work to reach an agreement and ensure that all involved under stand it.

Listening

The third skill in effective communication is to be an active listener. Active listeners are patient and do not interrupt until the other person has finished communicating their thoughts. Active listeners show respect for the comments, acknowledge them, and reiterate the comment or concern to make sure that it was heard correctly. Active listeners use open body language and neutral expressions to ensure that the speaker feels they are being heard.

Good leaders ensure that the opinions of their team members and others that are present are given the space to comment or communicate issues and concerns, regardless of their experience or expertise. Often, those unfamiliar with a particular situation or with a different background can provide valuable insight which can lead to new, out of the box thinking and problem solving.

CREW FITNESS

Drugs / Alcohol / Fatigue

Drugs, alcohol, and fatigue can have serious impacts on a crew member's ability to make effective decisions. The CARs contain specific regulations with regards to alcohol, drugs, and fatigue, and prohibits persons from acting as a crew member if they:

- are suffering or are likely to suffer from fatigue;
- have consumed an alcoholic beverage within the previous 12 hours;
- are under the influence of alcohol; or
- are using any drug/medication that impairs the person's faculties to the extent that aviation safety or the safety of any person is endangered or likely to be endangered.

Marijuana

Transport Canada has issued specific policy with regards to the use of marijuana. In addition to the regulations above, crew members must abstain from the use of marijuana (including CBD products) for a minimum of 28 days prior to participating in flight operations.

> Tip: As part of your crew briefing, even if you are the only crew, check yourself and your crew to make sure you are up to the task! Ask your team specifically if everyone is feeling well and able to proceed at the start of every flight operation.

Pre-Flight Check Yourself

You are used to checking your RPAS to ensure it's safe to fly, but what about the pilot? The "IM SAFE" acronym is a very useful tool that can be used to assess a crew member's ability to focus on and perform the task at hand.

It's important to consider all of the factors when assessing yourself. While it is not necessary to answer all points positively, it is important that you recognize the effect that a particular factor is likely to have on your performance. It may necessitate taking an alternate course of action to prevent an issue from becoming a more serious or dangerous situation.

I	ILLNESS	Do I have any symptoms?
M	MEDICATION	Have I taken any prescription or over-the-counter drugs? Are there unintended side effects?
S	STRESS	Am I under psychological pressure from this job? Other jobs? Family, medical or money problems?
A	ALCOHOL	Have I had anything to drink in the last 12 hours? Am I hungover? Am I under the influence of another substance?
F	FATIGUE	Are you feeling tired? (you should have had sufficient rest in the previous 24 hours and should feel alert)
E	EATING and DRINKING	Are you feeling hungry or thirsty? (you should have sufficient and proper nutrition and hydration)

Physiological Human Factors

There are some conditions that, if you are experiencing them, you must not in any way be responsible for an RPAS operation. Some of these are logical. Being drunk or high obviously precludes you from operating an RPAS, as does being stressed to a point where your concentration and focus are impacted. Others are less obvious but still impactful. You will find a few examples listed below. The Aeronautical Information Manual (AIM) is an excellent source for more information on physiological risks.

Hypoxia

Hypoxia can come in many forms but essentially means the same thing - your brain and body do not have enough oxygen to function. It could be that the environment has insufficient oxygen or, as is the case with carbon monoxide poisoning, the body cannot process oxygen even with fresh air available. Be mindful when operating at high elevations in the thin atmosphere for symptoms such as euphoria, a headache, blurred vision and nausea. These are symptoms of hypoxia, including carbon monoxide poisoning. Carbon monoxide is present in exhaust gas from vehicles and generators and can be encountered at any elevation.

Scuba Diving

If you enjoy scuba diving, there are some additional considerations for pilots to keep in mind. While some of the baseline rules really only apply to traditional aviation at risk of rapid decompression at high altitudes, it is still wise for ground-based pilots to restrict operations at high elevations after they have been scuba diving.

- Avoid altitudes of up to 8000’ ASL for 12 hours after a dive that did not require decompression stops,
- Avoid altitudes of up to 8000’ ASL for 24 hours after a dive that did require decompression stops,
- Avoid altitudes of 8000’ ASL or higher for at least 24 hours after any type of dive.

Summary
When it comes to assessing and determining an acceptable level of risk to a particular operation or to operate as a PIC, experience and information are your best tools. Give yourself time to carefully consider all of the factors at play, gather any further information and determine what “outs” or alternatives exist. Being educated on regulation and aircraft limitations is also vital as clients are much more amenable to a change if they understand the “why” behind a “no” or “not today”.

RISK ASSESSMENT

Operating an RPAS means accepting a certain level of risk. When operating, the pilot in command or PIC is continuously processing information regarding themselves, their crew, the aircraft, the environment, the operation and the entire flight situation in order to make right decisions. This flow and decision-making process affects and informs the assessment and management of risk.

Standard operating procedures or SOPs are put in place (and sometimes enforced through regulation!) to help pilots assess and manage risk to themselves and others. Adoption of a few human-factors focused best practices such as the “IM SAFE” checklist above will help assess for risks that might otherwise go unnoticed in your regular SOPs.

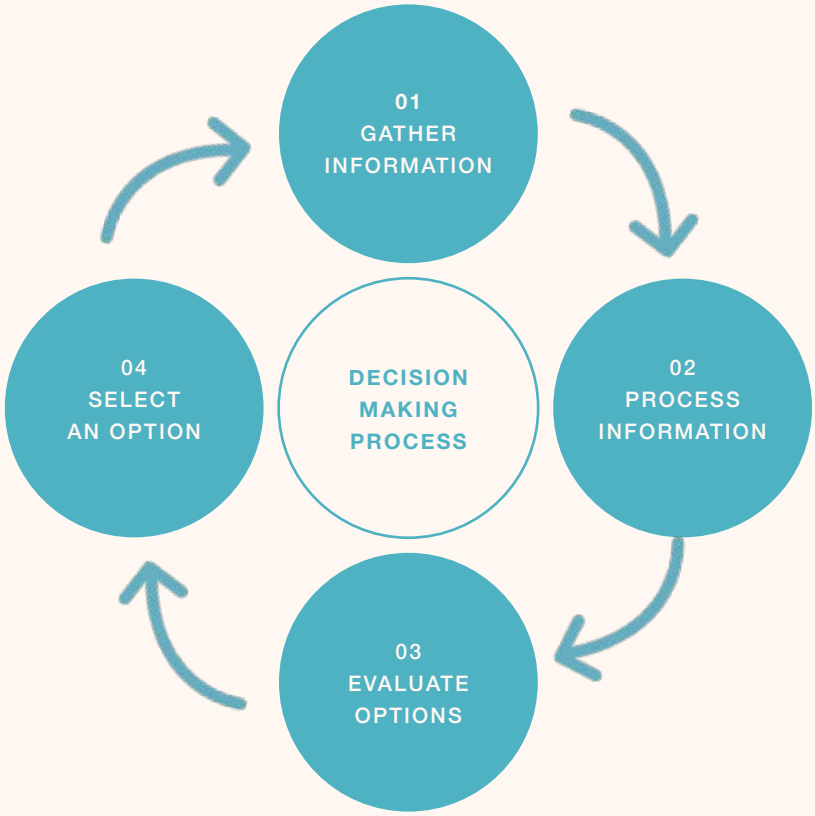
DECISION MAKING

Decision-making is a critical skill to develop as a pilot as it informs the ability to conduct safe operations. The human brain is fallible, and implementing a procedure around making decisions is a good practice to employ. Particularly in emergency events or unusual circumstances, procedures can help bring structure and order that will allow for more effective problem resolution.

The decision-making process will vary depending on the amount of time that is available.

Ample-Time Decision-Making

The general decision-making process involves gathering and then processing information, evaluating and choosing an option and then assessing the results.



With ample-time decision-making, information gathering and processing is happening nearly constantly with vigilance and knowledge created from situational awareness. Good situational awareness helps prevent small mistakes or the active failures mentioned with regard to Reason's Model. It is also an essential skill to develop as a crew as it allows the mind to constantly process "what ifs" and amend them as new information comes in.

The next step is to evaluate options which involves accurately diagnosing the issue to resolve, generating solutions and assessing the associated risks.

> TIP: It is important to involve crew opinions when possible when evaluating options. Cooperative collaboration is more effective than a mind working solo!

Finally you'll need to select which of the suitable options to act upon. This can be challenging, as it is not always clear which offers the greatest chance of success. Staying calm throughout the decision-making process will help you to make rational, logical decisions.

The moment you choose which option to pursue, the cycle resets! Now you can begin collecting information on how your decision is playing out and start all over again.

This process happens often without much thought given to the steps. Reviewing them regularly helps to organize your mind, particularly when you encounter more time-critical decision-making tasks.

Time-Critical Emergency Decision-Making
Decisions in this category need to be made quickly and often under duress. Experience plays a very important role in such decisions as there is little if any time to gather information. They typically require a gut-instinct reaction time and are usually (hopefully!) not something you encounter regularly. For this reason, training and checklists become very important in these scenarios. Practicing or simulating your immediate steps in the event of, for example, a fly-away, speeds up the steps of the decision-making process allowing you to take action nearly immediately. Under heavy workloads, managing situations that require time-critical decision-making becomes much tougher. Aim to delegate non-essential tasks to other crew members to alleviate workload whenever possible.

Make Decisions in Advance
Both with flight and operation planning, making as many decisions

in advance as possible will avoid you from being overloaded with too much information when you're already occupied with flying. This requires planning and understanding the activities, environment, equipment, and resources involved in your operation.

For example, you might get delayed en route to a flight. You could decide in advance, "If I don't make it to the site by 4 o'clock, we won't fly today" because you know trying to cram your safety procedures and flight into a short time frame won't be safe.

Another example might be taking active precautions in advance when flying in cold weather, by setting a low battery warning at a higher percentage than normal to provide an additional safety margin and eliminate the need to deal with a low battery situation in real time.

PERCEIVED PRESSURES

Perceived pressures can be real, fabricated or magnified by a person's own perceptions of a situation. Pressure often leads to increased stress so it is important to recognize and minimize outside stressors prior to flight to reduce the impact they can have on safety.

Pressures from Family and Self

Family pressures come in many forms. They can manifest themselves as expectation pressures, or pressure from relationships, financial performance, and even getting home in time. Perhaps you've changed careers to be more involved with RPAS. This might have meant a pay cut and significant investment in new equipment. The stress of financial burdens and the need to "prove yourself" can lead to unhealthy or unsafe environments as you and your equipment are pushed to your limits.

It is important to set personal limits to prevent overwork or unsafe work. Communication is key to form realistic expectations that do not over-tax your capabilities.

Pressures from Employers or Clients
Employer's goals can sometimes differ from a pilot's goals. Some more disreputable employers will push pilots to take risks and then blame the pilot if something goes wrong. Countering these pressures with procedure, minimums and knowledge of regulation will empower you to confidently turn down unsafe work and explain your rationale. Most employers are much more comfortable hearing a "no" if there is a valid reason behind it. Many expect you as the expert to inform them when they are pushing the limits.

Pressures from Friends
Flying with friends can sometimes lead to unsafe practices if you make flight decisions based on another person's skill, aircraft capability, or challenge. Be both confident in your abilities and understand your limits. Recognize the pressure that can exist in these scenarios and make the choices that allow you to fly with friends again another time.

HAZARDOUS ATTITUDES

It is important to recognize hazardous attitudes in yourself, your crew and your clients. Being aware of how particular attitudes can create hazardous environments is important to maintaining flight safety and a productive, enjoyable and communicative flight environment.

Anti-Authority—"Don't tell me what to do!"
When one believes they are above the rules or that regulations and safety procedures don't apply to them, they are displaying anti-authority tendencies. It is always a pilot's responsibility to question any authority if they believe what they are being asked to do is unsafe. Making a practice out of neglecting checklists or pushing back at ATC or regulators without a valid reason can indicate a hazardous attitude.

Impulsivity—"Just do something!"
Impulsivity is the tendency to act on a whim, displaying behavior

characterized by little or no forethought, reflection, or consideration of the consequences. Doing anything just so something is being done is a demonstration of the hazardous attitude of impulsivity. It ignores the decision-making process and can lead to irrational choices. If you find time-pressures are causing you to make impulsive decisions, review the decision-making process to make deliberate, informed choices.

Invulnerability—"That can't happen to me!"
The hazardous attitude of invulnerability is the belief that you are somehow immune to factors that affect all. It can become an issue as one begins to believe "well it's never happened before so it won't happen now!" and chooses to ignore safety concerns.

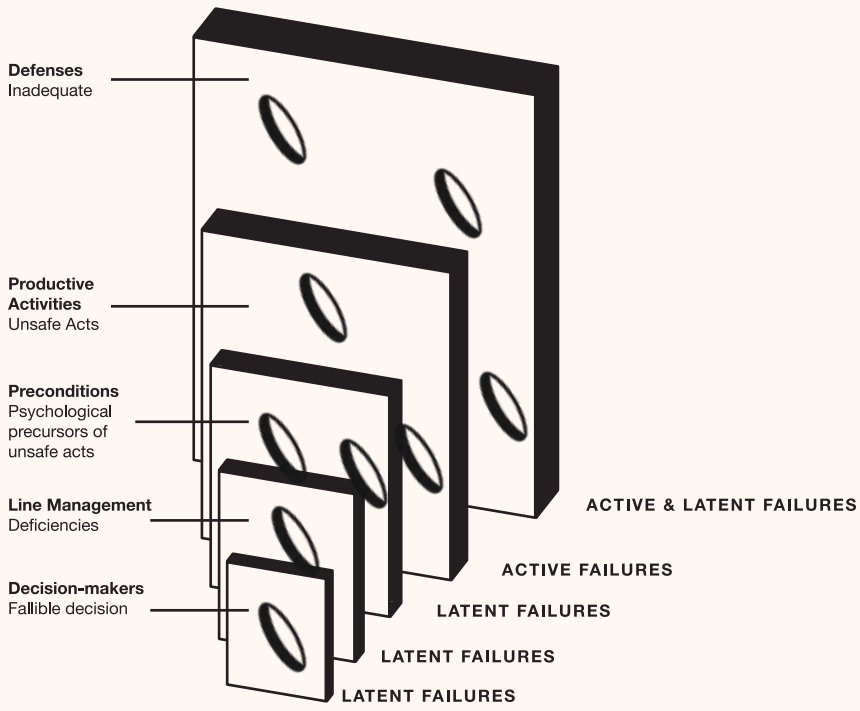
Macho—"I can do it!"
Pushing on despite risks as a way of demonstrating skill or to impress others is a characteristic of the hazardous macho attitude. Confidence is good, but allowing it to turn into dangerous or foolish behaviour is when it has gone too far and can significantly increase risks.

Resignation —"What's the point?"
Lacking confidence and conviction to believe anything you do will have an effect over the things that happen to you is a demonstration of the hazardous attitude of resignation. This is particularly dangerous in emergency situations as it leads to a lack of action or effort to identify appropriate actions.

REASON'S MODEL

Reason's model is based on the notion that businesses have at least two forces working against each other, competing for the same resources of money, time and personnel. These forces are profitability and safety. Profitability is easy to measure and understand and largely determines what can be spent to improve an operation. The second force, safety, is harder to quantify and less tangible. The money spent on safety measures and the probability of an accident is difficult to determine.

Reason states that it is easier to pay attention to profitability than safety and this in itself creates an increased risk of an accident.



The figure above represents Reason's model. It consists of five control layers together which are applicable to the RPAS operating environment. The holes represent gaps in the layer's defenses. In a rare case when holes in all five layers line up, an accident occurs. From a human factors perspective, the goal is to minimize the

number of holes in each layer so the chances of them lining up becomes unlikely.

Decision Makers: A company's attitudes to documentation and operating procedures, such as lacking them entirely, does not directly cause a problem but can set the stage for it. Problems in this layer are called latent failures because they can lie hidden for years without directly causing an accident.

Line Management: This layer includes operational procedures and training. Similar to the decision maker layer, problems in this layer are termed latent failures. Inconsistency in operating procedures or lack of training introduces gaps which can lead to problems and risks down the road.

Preconditions: This layer consists of all the circumstances of a particular flight. It includes items such as the crew's condition, aircraft maintenance, and environmental conditions. These too are latent failures as they may not directly cause a problem, but their effects in the background do affect the outcome.

Productive Activities: As the name implies, this is the first layer that contains active failures that directly cause a problem. Examples include misreading a checklist, violating regulations or ignoring critical information such as a low battery warning.

Defences: This layer can involve active and latent failures in mechanisms that were put in place to catch mistakes or prevent problems. A latent failure could be failing to employ visual observers for complex flights and an active failure would be relying completely on your RPAS's camera screen rather than splitting your attention between it and the RPA itself.

THREAT AND ERRORS

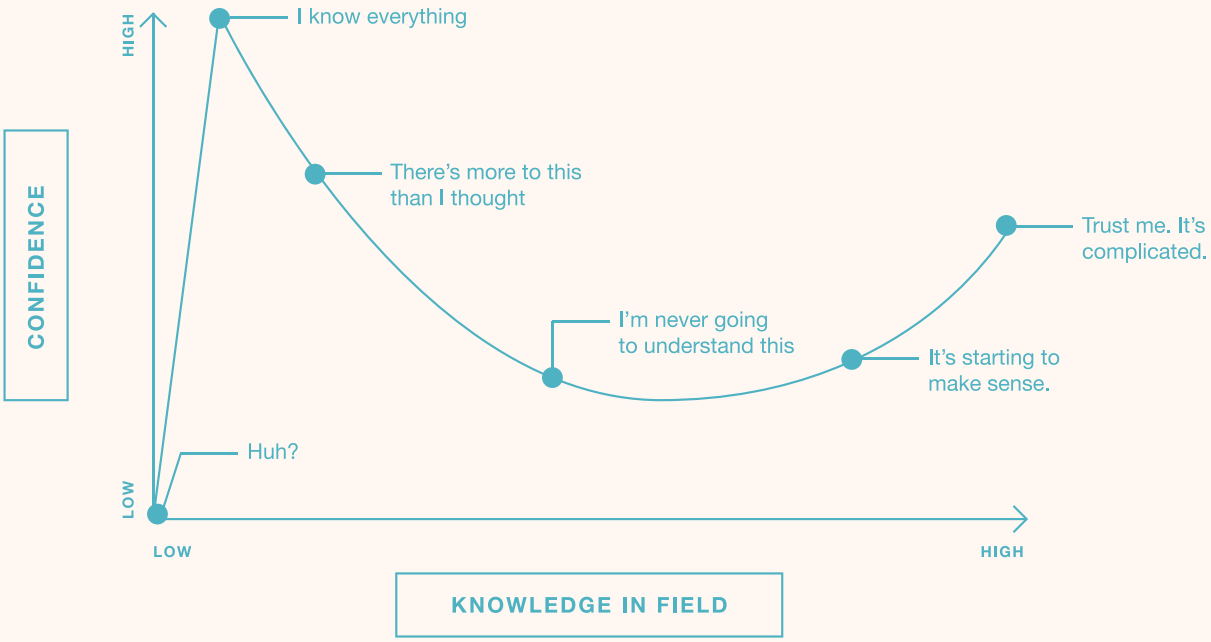
Threat and Error Management (TEM) is a progressive series of safeguards designed to stop threats from leading to errors, errors from leading to an undesired aircraft state, and finally from an undesired aircraft state to a situation that can no longer be managed.

The intent is to:

1. Identify and analyze potential threats in order to avoid them.
2. Identify strategies to handle anticipated threats.
3. Promptly detect and mitigate errors created by unmanaged threats before they lead to an undesired aircraft state.
4. Identify actions that can return an aircraft to a desired state after an error has occurred, focusing on the desired state, and not on fixing the error that caused the current state.

Relationship of Knowledge and Confidence

There's a common fallacy that can develop when a new skill is being learned. It is the tendency to develop an overconfidence in oneself when you don't know enough to know what you don't know.



To counter the threat that this overconfidence can cause, adopt a mindset of being open to learning and maintaining humility. There's always something new to learn to improve your skills and knowledge.

DESIGN AND AUTOMATION

Two possible sources of latent failures in RPAS operation are through design - mainly as it relates to displays or controls - and automation.

Design

If you're paying attention, you can notice examples of poor design in many areas of the built world. Poor design is often inconvenient if not particularly hazardous. Think of stairs that are too wide for a normal stride, restroom mirrors that are mounted too low, or doors that swing the wrong way.

In aviation, it's important to ensure our systems are designed in a way that reduces latent failures and makes it harder for pilots to make errors. Flying is a closed-loop system. The feedback on performance is linked to the control a pilot has. The system needs to provide an accurate means of reporting the state of the system and the operator needs to have good, sensitive controls to manipulate it. When there is a breakdown in design of this system, it leads to errors in interpretation and control.

Automation

Automation is closely related to design and is a key component in the operation of many RPAS. While automation reduces the physical workload of a pilot, it does not reduce the mental workload. Humans are naturally better "operators" than they are "monitors". The detachment from a system that automation can create results in new challenges for the pilot to maintain the safety of the flight.

To maintain safety during automated flights, pilots should continue to note key telemetry information from their RPA with quick glances. Avoiding “head down” behaviour improves situational awareness and the ability to react to situations.

The use of visual observers whenever the pilot’s attention will be taken away from the RPA for an extended period of time is recommended.

There is a natural tendency to develop an over reliance on automation as well. Blindly accepting what the systems do or say can lead to mistakes, mishandling and compromising safety. Understand how to activate and deactivate levels of automation within the systems to ensure manual control can be regained when necessary. Practice these skills to ensure they are never rusty or unfamiliar.

Caution: Your RPAS may be easy to fly, however, it is very complicated to operate! It is your job to understand these complexities!

Guidelines for Automated Systems
Practice and learn to use automation settings before flying.
Many systems can be powered on without propellers indoors or offer simulation options to enable learning of the software before adding the complexity of flight.

- *Program the system in advance when possible*
  Aim to do as much programming before take-off as possible and land if you will need to have your head down for an extended period of time.
- *Familiarize yourself with all settings*
  The complexity of the system comes from the multitude of settings and options that you can change. Be sure you are familiar with them, what they are for, and the behaviours they will trigger.
- *Check your setting and assumptions*
  Assume you will catch an inaccuracy so your mind is primed to

see it. This level of suspicion helps automation remain an aid rather than a crutch.

- *Be aware of and counteract boredom/complacency*
  The more automated a flight, the easier it is to let the aircraft fly itself. Always be ready to take control, maintaining situational awareness at all times.
- *Divide workloads*
  Use your crew whenever possible to divide tasks so someone is always eyes-on the RPA.
- *Keep your head up*
  Keep your eyes on your RPAS and confirm what you're seeing with the telemetry provided by your system rather than solely watching the monitor or the RPA.
- *Be prepared to fly manually*
  RPAS typically have a few flight modes. Be familiar with each one of them and how they differ. Put the aircraft into the least-sensor-assisted mode and practice controlling it through to a safe landing from various orientations. You never want to be out of practice with this skill.

Flight Bag

A flight bag is an organized kit that should have all of the items ready to go that are either legally required for your flight, or that can make your flight operation go more smoothly. The entire sample list below may not be required for all flights, but should help you create a personalized kit.

ANEMOMETER	BINOCULARS	THERMOMETER	CHECKLISTS
REQUIRED DOCUMENTS See documents & logs section below	AVIATION RADIO	FLASHLIGHT	BASIC TOOL KIT
EMERGENCY CONTACTS	FLIGHT PLAN & CONTACTS	FLIGHT AUTHORIZATION FOR CONTROLLED AIRSPACE	FIRE EXTINGUISHER
FIRST AID KIT	CHARGERS, ADAPTERS & CORDS FOR ELECTRONIC DEVICES	SPARE SD MEMORY CARDS	LENS CLEANER
SUN SCREEN	BUG REPELLENT	CFS & CHARTS Electronic or Paper	HAT
WATER	SNACKS	CHECKLISTS	FLIGHT PLAN & KEY CONTACTS

Documents and Logs

DOCUMENTS REQUIRED ON-SITE

The CARs requires that RPAS pilots have certain documents with them at all times when operating their RPAS. These may be in a printed or electronic format. Procedural documents and manuals must be immediately available to all crew members during operations.

Certificates And Manuals

The CARs require that you have certain documents with you at all times when operating an RPAS. This includes the following:

- Your certificate of registration for the RPA you are operating (must also be marked on RPA)
- The Manufacturer's Operating Manual for the RPAS readily accessible to all crew
- Your Pilot Certificate
- Proof of Recency
- Completed Site Survey
- Normal Procedures
  (covering the procedures detailed in CARs 901.23(1)(a))
- Emergency Procedures
  (covering the situations detailed in CARs 901.23(1)(b)

CANADA FLIGHT SUPPLEMENT AND CHARTS

Pilots should have access to the current CFS and to current aeronautical charts for the area they are operating in. These publications can be purchased in printed format from NAV CANADA's publications website or pilot supply retailers. They can also be accessed through applications such as ForeFlight or FltPlan Go. While other airspace tools can aid in flight planning they are not a substitute for having access to official aeronautical charts and the CFS.

Logs

Pilots are also required to keep two types of logs and produce them for inspection if requested. They may be kept as a hard copy or digitally, so long as the digital copies are protected from tampering and loss, and can be printed for submission to Transport Canada upon request.

Flight Logs (12 month retention)

- a record containing the names of the pilots and other crew members who are involved in each flight and, in respect of the system, the time of each flight or series of flights,
- This log does not need to be transferred to the new owner upon sale of the RPAS.

Maintenance Logs (24 month retention)

- a record containing the particulars of any mandatory action and any other maintenance action, modification or repair performed on the system, including:
  — the names of the persons who performed them,
  — the dates they were undertaken,
  — in the case of a modification, the manufacturer, model and a description of the part or equipment installed to modify the system, and
  — if applicable, any instructions provided to complete the work.
- This log should be transferred to the new owner upon sale of the RPAS.

Exam Preparation Tips

BEFORE YOU WRITE

The following provides guidance for those writing the online Transport Canada RPA pilot certification exams.

PREP YOUR MATERIALS

The following documents are good references to review and have available during your exam:

- This guide,
- Aeronautical Information Manual,
- Canadian Aviation Regulations Part IX
- TP-15263 Knowledge Requirements for Pilots of Remotely Piloted Aircraft Systems Oct 2018 Edition,
- Canadian Flight Supplement,
  Review the reference section at the front for how to read the entries in the CFS
- VFR/VTA Navigation Chart with a legend,
- Transport Canada Human Factors for Aviation Basic Handbook TP 12863,
- Transport Canada Human Factors for Aviation Advanced Handbook TP12864,
- For the advanced exam, any good general aviation pilot information source book such as “From the Ground Up”.

TIP! Electronic PDF versions of documents make searches faster! CTRL + F will be helpful.

PREPARE TO MAKE NOTES

The exam is multiple choice and completed online, but it's a good idea to keep a notepad handy to quickly jot down questions you'd like to revisit, topics to google, or topics you'd like to study more later.

APPROACHING THE EXAM QUESTIONS

Exams can be stressful and people often rush and misread questions or make assumptions that cause them to get the answer wrong. Here are some general tips for approaching the exam questions.

- Make sure you read the questions very carefully and completely before looking at the multiple choice answers.
- Read all of the answers completely paying attention to all of the words. Resist the urge to choose the first answer that looks correct as there could be another answer that is *more* correct. For example if you know the answer is 400', there may be a 400' ASL option and another that says 400' AGL.
- Eliminate answers that you know are incorrect to allow you to focus on the possible correct answers.
- Watch the syntax of the answers carefully, you may get a question that gives you a list of 4 items (e.g. a,b,c,d) as choices to be used in the multiple choice answers that also have letters a,b,c,d, choices for the answers. This can be confusing. Be careful to separate the choice option letters from the answer letters. Below is an example:

  Which of the following 4 shapes have right angles?

  A. Circle B. Square C. Triangle D. Rectangle

  A. B., C., D.
  B. A., B., C.
  C. A., B., D.
  D. A.,C., D.

You are best to answer the questions that you know for sure and skip the questions you are not sure about and come back to them. You will see indications of the questions that you haven't answered when you get to the end of the exam. You can then go back and dig a little deeper into the questions you didn't answer during the first round. If you have questions that you think you might want to go back to but you did provide an answer, make a note of the question number and go back and review your answer later. To recap:

1. Answer the questions you know for sure
2. Answer and make note of the questions you are reasonably sure of but want to verify if you have time after answering all the questions.
3. Skip questions that you don't know at all
4. When you have finished the last question go back and research the questions you skipped
5. If you still have time, go back and double check the questions you made note of in step 2 above.

AFTER A FAILED ATTEMPT

If you are not successful after writing your RPAS exam in the Transport Canada Drone Management Portal (DMP), do not be hard on yourself. You're not the first person to need to write it more than once and you won't be the last.

You will be presented with a summary of your results to see what areas in particular you need to review. From the main DMP page, under the "Take an Exam" section, select "View Exam Results". Choose the exam you wish to review if you have more than one. The results of your exam will be summarized at the top of the page. If you scroll down you will see the concepts within each section that you need to review.

NOTE: You will need to wait 24 hours before you are eligible to write the exam again.

RESOURCES

General Resources

PART IX CARS
https://lois-laws.justice.gc.ca/eng/regulations/SOR-96-433/FullText.html#s-900.01

AIM
https://www.tc.gc.ca/en/services/aviation/publications/tc-aim.html

DRONE MANAGEMENT PORTAL
https://gart.tc.gc.ca/secure/UASIMS-SGISASP/eng/

TC DRONE SAFETY PAGE
https://www.tc.gc.ca/en/services/aviation/drone-safety.html

DRONE SITE SELECTION TOOL
https://nrc.canada.ca/en/drone-tool/

NAV CANADA NAV DRONE APP
https://www.navcanada.ca/en/flight-planning/drone-flight-planning.aspx

CHOOSING THE RIGHT SCHOOL
https://tc.canada.ca/en/aviation/drone-safety/drone-pilot-licensing/find-drone-flight-school

MAAC EXEMPTION
https://www.maac.ca/en/transport_canada_exemption.php

PARKS CANADA REGULATIONS
https://www.pc.gc.ca/en/voyage-travel/regles-rules/drones

RESOURCES

CANADIAN AIRSPACE VIEWER
https://airspace.canadarasp.com/

FLTPLAN.COM
http://www.fltplan.com

NAV CANADA WEATHER RESOURCES
https://www.navcanada.ca/en/flight-planning/flight-planning-and-reporting.aspx

KP INDEX
https://www.spaceweather.gc.ca/forecast-prevision/short-court/zone-en.php

Textbook

UNMANNED - TEXTBOOK OF RPAS STUDIES, 3rd EDITION
by Aviation Publishers

Additional Resources by Knowledge Area

HUMAN FACTORS

- Human Factors for Aviation – Basic Handbook (TP12863)

METEOROLOGY

- Nav Canada Local Area Weather Manuals
  https://www.navcanada.ca/en/aviation-weather-services-guide.pdf
- NAV CANADA Aviation Weather Services Guide
  https://www.navcanada.ca/en/aeronautical-information/operational-guides.aspx
- Environment Canada - AWARE: The atmosphere, the weather and flying
  https://publications.gc.ca/collections/collection_2013/ec/En56-239-2011-eng.pdf

THEORY OF FLIGHT

- US Resource Handbook (use caution as this manual references US regulations)
  https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/

RADIOTELEPHONY

- RIC-21 — Study Guide for the Restricted Operator Certificate With Aeronautical Qualification (ROC-A)
  https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf01397.html