Knowledge Requirements

for

Pilots of Remotely Piloted Aircraft Systems

250 g up to and including 25 kg,
Operating within Visual Line-of-Sight (VLOS)

Second Edition
October 18, 2018

Please direct your orders and inquiries to:

The Order Desk
Operational Support Services
Transport Canada (AAFBD)
330 Sparks Street
Ottawa ON K1A 0N8
Telephone: 1-888-830-4911 (in North America) 613-991-4071 (other countries)
Fax: 613-991-1653
E-Mail: Publications@tc.gc.ca

TP 15263E
(Revised 10/2018)

You may reproduce this guide as required and it can be found at
http://www.tc.gc.ca/en/services/aviation/publications/tp-15263.html

TABLE OF CONTENTS

Preamble

This document was prepared by a joint Transport Canada/industry working group.

This knowledge document serves as the ground training and examination guide for pilots of Remotely Piloted Aircraft Systems (RPAS). It is in accordance with the amendments to the *Canadian Aviation Regulations* (CARs) for sRPAS operations that are to come into force in 2018/2019. This guide covers the knowledge required to operate sRPAS in Canada. It is not necessarily a comprehensive list – sRPAS operating and training organizations may find the need to supplement these topics. The written examinations, as set by Transport Canada, will be in accordance with the knowledge listed in this document. Both this document and the examinations may be amended as required.

Regulatory history

The Canadian Aviation Regulatory Advisory Council (CARAC) Unmanned Aircraft System Program Design Working Group made recommendations for the safe integration of sRPAS operations within visual line-of-sight (VLOS) in Canadian airspace.

The key principles for sRPAS-related regulatory changes were approved by the CARAC Technical Committee in June 2012 and then by the Transport Canada Canadian Aviation Regulatory Committee (CARC) in October 2012. They were adopted as best practice guidance for Transport Canada Inspectors and applicants for a Special Flight Operations Certificate (SFOC) - Unmanned Aircraft Systems. Those Best Practices have now been incorporated into regulations and standards that normalize the operation of sRPAS operating VLOS.

This document is provided to guide trainers and pilots in the training required, and the examinations subjects to be covered when operating sRPAS VLOS under the new CAR Part IX.

New regulatory structure for RPAS

- RPAS will be regulated according to the CARs. Part IX of the CARs will deal with RPAS according to the divisions of mass and operating environments in the diagram below. The immediate regulations will cover RPAS with a MTOW of 250 grams (0.55 lb) up to and including 25 kg (55 lb) operating VLOS.

- Operating environments will be subdivided in to basic operations and advanced operations

- Other operations using RPAS that do not fall within the scope of the regulations will require a Special Flight Operations Certificate–RPAS from Transport Canada. This includes operations during which the RPAS is operated beyond visual line-of-sight (BVLOS).
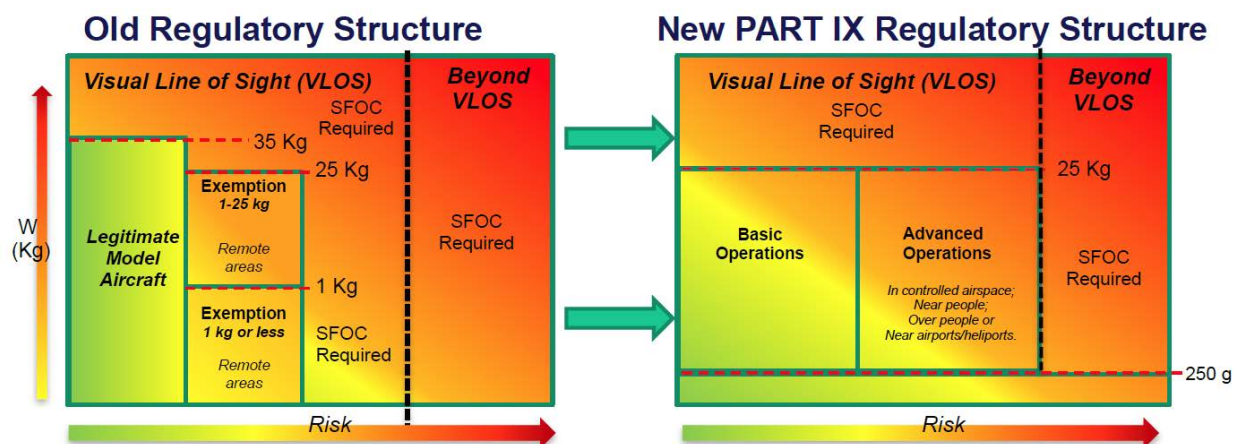
General small RPAS exam information

Where to write the examinations
The examinations required for the operation of sRPAS may only be completed online via the Transport Canada Drone Management Portal.

Examination prerequisites
Candidates for exams must create an account on the Transport Canada Drone Management Portal.
NOTE: Applicants must be able to read the examination questions in either English or French without assistance.

Examination rules
As per CARs 901.58, 901.67, and 901.84 with respect to examinations related to RPAS:
No person shall,
    (a) copy or remove from any place all or any portion of the text of the examination;
    (b) give help to or accept help from any person during the examination; or
    (c) complete all or any portion of the examination on behalf of any other person;

Materials required

The examinations are delivered via computer. However, we suggest having a pencil and paper handy before beginning the examination, to make diagrams or execute calculations during the examination.

Time limits and pass marks

Examination	Questions	Time limit	Pass mark
Remotely Piloted Aircraft Systems–Basic Operations:	35	1 ½ hour	65%
Remotely Piloted Aircraft Systems–Advanced Operations:	50	1 hour	80%
Remotely Piloted Aircraft Systems–Flight Reviewers:	30	1 ½ hour	80%

Rewriting of examinations

In the case of any examination for operation of sRPAS, the examination may be rewritten after 24 hours.

Examination feedback

Feedback statements in the results letter will inform the candidate where questions were answered incorrectly.

> Example of feedback statement*:*
>
> Identify classes of airspace from an aeronautical chart*.*

Small RPAS pilot knowledge requirements

Knowledge requirements for sRPAS pilots operating VLOS are shown in the following tables. The applicable type of operation (basic and advanced) is shown to the left of the topics. Sample learning objectives are shown to the right of the topics. The list of sample objectives is not all-inclusive, its purpose is to illustrate the depth of knowledge required to operate sRPAS in Canadian airspace.

Types of operation (basic operations, advanced operations) are set out in the *Canadian Aviation Regulations*, Part IX. There are minimum knowledge requirements for the pilots of sRPAS operating in each of those groups.

Applicants for the pilot certificate – small remotely piloted aircraft (VLOS) – basic operations shall demonstrate their knowledge by writing the Transport Canada multiple choice examination based on the indicated applicable subjects contained in this guide and covering the subjects set out in Standard 921.01.

Applicants for the pilot certificate – small remotely piloted aircraft (VLOS) – advanced operations shall demonstrate their knowledge by writing the Transport Canada multiple choice examination based on

the indicated applicable subjects contained in this guide and covering the subjects set out in Standard 921.02.

Applicants for the flight reviewer rating attached to the pilot certificate – small remotely piloted aircraft (VLOS) – advanced operations shall demonstrate their knowledge by writing the Transport Canada multiple choice examination on the indicated applicable subjects contained in the "Knowledge areas" section of this guide related to advanced operations and "Appendix A: Flight review guide - sRPAS exercises" related to conducting a flight review covering the subjects set out in Standard 921.03.

Knowledge areas

Section 1: air law, air traffic rules and procedures

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives
Basic	Advanced		The small RPAS pilot operating within visual line of sight must be able to:
		Aeronautics Act	
✓	✓	**s3-Definitions**	• Define aerodrome, airport, and pilot-in-command.
		***Canadian Aviation Regulations* (CARs)**	
		Part I–General provisions	
		101–Interpretation	
✓	✓	101.01 Interpretation (definitions)	• Define common terms used in the *Canadian Aviation Regulations*, such as day, night, VFR. • State the definition of remotely piloted aircraft. • State the definition of small remotely piloted aircraft. • Define remotely piloted aircraft system.
		102–Application	
✓	✓	102.01 Application	• State that the regulations do not apply to indoor or underground operations.
		103–Administration and compliance	
✓	✓	103.02 Inspection of aircraft, requests for production of documents and prohibitions	• State who may demand to inspect aviation documents.
	✓	103.03 Return of Canadian Aviation Documents	• State that computer-stored records may be used in place of paper records if measures are taken to protect them.
	✓	103.04 Record keeping	

		Part III–Aerodromes and airports	
		301–Aerodromes	
	✓	301.01 Application	• Explain that persons, vehicles, obstacles and operations at aerodromes are subject to the approval of the aerodrome operator and the appropriate air traffic control unit.
	✓	301.08 Prohibitions	
	✓	301.09 Fire prevention	
		302–Airports	
	✓	302.10 Prohibitions	• State the restrictions/rules for activities on an aerodrome, or airport.
	✓	302.11 Fire prevention	
		Part VI–General operating and flight rules	
		601–Airspace	
		Airspace structure, classification and use	
	✓	601.01 Airspace structure	• Describe the horizontal and vertical limits of the various classifications of airspace, control areas, special use airspace.
	✓	601.02 Airspace classification	
	✓	601.03 Transponder airspace	
	✓	601.04 IFR or VFR Flight in class F special use restricted airspace or class F special use advisory airspace	• Identify the altimeter setting region and the standard pressure region.
	✓	601.08 VFR flight in class C airspace	• Recall that advanced operations in Class F airspace require the permission of the airspace operator.
	✓	601.09 VFR flight in class D airspace	
			• Describe the communications required with air traffic control (ATC) for operating a small RPA VLOS within class C or D airspace.
		Aircraft operating restrictions and hazards to aviation safety	
✓	✓	601.14 Interpretation	• Recall the restrictions to operations in the vicinity of forest fire areas.
✓	✓	601.15 Forest fire aircraft operating restrictions	
	✓	601.16 Issuance of NOTAM for forest fire	• Describe the circumstances when a small RPAS is permitted to be operated in the vicinity of a forest fire.
✓	✓	601.17 Exceptions	
✓	✓	601.20 Projection of directed bright light source at an Aircraft	
✓	✓	601.21 Requirement for notification	• Describe the process required to legally use

✓	✓	601.22 Requirement for pilot-in-command	a LIDAR (light detection and ranging) on a small RPA.
		602–Operating and flight rules - general	
		Operation at or in the vicinity of an aerodrome	
	✓	602.96 General	• State that pilots of small RPAs shall avoid flying the RPA in the traffic pattern at an aerodrome.
	✓	602.97 VFR and IFR aircraft operations at uncontrolled aerodromes within a mandatory frequency (MF) Area	• Recall the minimum operating conditions for VFR flight in uncontrolled airspace.
	✓	602.98 General MF reporting requirements	
	✓	602.99 MF reporting procedures before entering manoeuvring area	
	✓	602.100 MF reporting procedures on departure	
	✓	602.101 MF reporting procedures on arrival	
	✓	602.102 MF reporting procedures when flying continuous circuits	
	✓	602.103 Reporting procedures when flying through an MF area	
		Radio communications	
	✓	602.136 Continuous listening watch	• Describe the actions to be taken in the event of a two-way radio communication failure when flying in class C or D airspace.
	✓	602.138 Two-way radio communication failure in VFR flight	
	✓	602.146 ESCAT Plan	
		606–Miscellaneous	
✓	✓	606.01 Munitions of war	• Recall that weapons may not be carried on RPAS unless authorized.
		Part IX remotely piloted aircraft systems	
		Division I General provisions	
✓	✓	900.01 Interpretation	• Define common terms used in RPAS

			operations such as: command and control link, payload, visual observer.
✓	✓	900.02 Application	
		900.03 Reserved	
		900.04 Reserved	
		900.05 Reserved	
		Division II General prohibition	
✓	✓	900.06 Reckless or negligent operation	• Recall the prohibition against endangering aviation safety or the safety of any person.
		Subpart 1 Small remotely piloted aircraft	
		Division I General provisions	
✓	✓	901.01 Application	• State that Remotely Piloted Aircraft having a maximum takeoff weight (MTW) less than 250 g are not subject to the rules in Part IX Subpart 1 of the *Canadian Aviation Regulations*.
		Division II Remotely piloted aircraft registration	
✓	✓	901.02 Registration of remotely piloted aircraft	• Recall that all small RPA are required to display the registration number.
✓	✓	901.03 Registration number	
✓	✓	901.04 Qualifications to be registered owner of a remotely piloted aircraft	• Recall that the pilot must have easy access to the certificate of registration when operating a registered small RPA.
✓	✓	901.05 Registration requirements	
✓	✓	901.06 Register of remotely piloted aircraft	
✓	✓	901.07 Conditions where certificate of registration is cancelled	
✓	✓	901.08 Change of name or address	
✓	✓	901.09 Access to certificate of registration	
		901.10 Reserved	

		Division III General operating and flight rules	
✓	✓	901.11 Visual line-of-sight	• Recall that small RPA shall give way to manned aircraft at all times.
✓	✓	901.12 Prohibition—emergency security perimeter	
✓	✓	901.13 Prohibition—Canadian domestic airspace	• Recall the rules regarding the use of visual observers.
✓	✓	901.14 Prohibition—airspace	
✓	✓	901.15 Inadvertent entry into controlled airspace	• State what aeronautical information must be consulted before flight.
✓	✓	901.16 Flight safety	
✓	✓	901.17 Right of way	• State that RPAS operations must remain in Canadian domestic airspace.
✓	✓	901.18 Avoidance of collision	
✓	✓	901.19 Fitness of crew members	• Recall the requirement to notify air traffic control if a flyaway is likely to enter controlled airspace.
✓	✓	901.20 Visual observers	
✓	✓	901.21 Compliance with instructions	
✓	✓	901.22 Living creatures	• State which procedures must be established for normal and emergency operations for all small RPA operations
✓	✓	901.23 Procedures	
✓	✓	901.24 Pre-flight information	
✓	✓	901.25 Maximum altitude	• State the minimum distance that a RPA must remain from a person.
✓	✓	901.26 Horizontal distance	
✓	✓	901.27 Site survey	• State the minimum visibility required for the operation of a RPA.
✓	✓	901.28 Other pre-flight requirements	
✓	✓	901.29 Serviceability of the remotely piloted aircraft system	• State the minimum distance that a small RPA must remain from an aerodrome and from a heliport.
✓	✓	901.30 Availability of remotely piloted aircraft system operating manual	
✓	✓	901.31 Manufacturer's instructions	• Recall that a small RPA may not be operated at or near an aerodrome in a manner that could interfere with aircraft operating in the established traffic pattern
✓	✓	901.32 Control of remotely piloted aircraft systems	
✓	✓	901.33 Take-offs, launches, approaches, landings and recovery	
✓	✓	901.34 Minimum weather conditions	
✓	✓	901.35 Icing	• State the minimum distance that a small RPA must remain from an airport and from a heliport when not operating under the
✓	✓	901.36 Formation flight	
✓	✓	901.37 Prohibition—operation of moving vehicles, vessels and	

		manned aircraft	Advanced Operations rules.
✓	✓	901.38 Use of first-person view devices	• Describe the factors that must be included in a "site survey" for the operations of all small RPA operations.
✓	✓	901.39 Night flight requirements	
✓	✓	901.40 Multiple remotely piloted aircraft	
✓	✓	901.41 Special aviation events and advertised events	• State the requirements for lighting when operating a small RPA at night.
✓	✓	901.42 Handovers	
✓	✓	901.43 Payloads	
✓	✓	901.44 Flight termination system	
✓	✓	901.45 ELT	
✓	✓	901.46 Transponder and automatic pressure-altitude reporting equipment	
✓	✓	901.47 Operations at or in the vicinity of an aerodrome, airport or heliport	
✓	✓	901.48 Records	
✓	✓	901.49 Incidents and accidents—associated measures	
		901.50 Reserved	
		901.51 Reserved	
		901.52 Reserved	
		Division IV Basic operations	
✓	✓	901.53 Application	• State the requirements to hold a pilot certificate–SRPA (VLOS)–basic operations.
✓	✓	901.54 Pilot requirements	
✓	✓	901.55 Issuance of pilot certificate—small remotely piloted aircraft (VLOS)—basic operations	• State what is required to operate a small RPAS in Basic operations
✓	✓	901.56 Recency requirements	• Recall the 24 month recency requirements for holders of pilot certificates-SRPA (VLOS).
✓	✓	901.57 Access to certificate and proof of recency	
✓	✓	901.58 Examination rules	
✓	✓	901.59 Retaking of an examination or a flight review	
		901.60 Reserved	
		901.61 Reserved	

			Division V Advanced operations	
		✓	901.62 Application	• State the requirements to hold a pilot certificate–SRPAS (VLOS)–advanced operations.
		✓	901.63 Pilot requirements	
		✓	901.64 Issuance of pilot certificate—small remotely piloted aircraft (VLOS)—advanced operations	• State what is required to operate a small RPA in advanced operations
		✓	901.65 Recency requirements	
		✓	901.66 Access to certificate and proof of recency	• Recall the 24 month recency requirements for holders of pilot certificates-SRPA (VLOS).
		✓	901.67 Examination rules	
		✓	901.68 Retaking of an examination or a flight review	• State the conditions under which it is permissible to operate a small remotely piloted aircraft at a lateral distance of less than 100 feet from another person.
		✓	901.69 Manufacturer declaration—permitted operations	
		✓	901.70 Operation of a modified remotely piloted aircraft system	
		✓	901.71 Operations in controlled airspace	• State the information that must be given to air traffic services when requesting flight in controlled airspace.
		✓	901.72 Compliance with air traffic control instructions	
		✓	901.73 Operations at or in the vicinity of an airport or a heliport–established procedure	
			901.74 Reserved	
			901.75 Reserved	
			Division VI Advanced operations—manufacturer requirements	
		✓	901.76 Manufacturer declaration	
		✓	901.77 Notice to the minister	
		✓	901.78 Documentation	
		✓	901.79 Record-keeping	
			901.80 Reserved	
			901.81 Reserved	
			Division VII Advanced operations—flight reviewer requirements	

	✓	901.82 Prohibition—flight reviewer	• State that a flight reviewer rating is required in order to conduct a flight review for a pilot certificate–SRPA (VLOS)–advanced operations.
	✓	901.83 Flight reviewer rating	
	✓	901.84 Examination rules	
	✓	901.85 Retaking of an examination or a flight review	
	✓	901.86 Training provider requirements	
	✓	901.87 Conduct of flight reviews	
		Subpart 2 Reserved	
		Subpart 3 Special flight operations—remotely piloted aircraft systems	
	✓	903.01 Prohibition	• Give examples of types of RPAS activities that would require a special flight operations certificate.
	✓	903.02 Application for special flight operations certificate—RPAS	
	✓	903.03 Issuance of special flight operations certificate—RPAS	
✓	✓	**Transportation Safety Board of Canada (TSB)–(refer to TC AIM-GEN 3.0)**	• State that the purpose of accident investigation is to prevent recurrence. • State the types of accidents that must be reported to the Transportation Safety Board of Canada.
		Air traffic services and procedures	
	✓	Air traffic and advisory services	• Determine who provides coordination or air traffic control service for the airspace being

			used (if applicable).
• Determine the MF/ATF and enroute frequencies (if applicable) for the operating area.
• Explain any traffic patterns of passing aircraft.
• Anticipate patterns of manned aircraft sharing the airspace.
• Determine the aeronautical radio frequencies in use for this airspace.
• Use appropriate phraseology in radio communication.
• Recognize clearances and instructions directed to other aircraft.
• Interpret the CFS with respect to airspace and location procedures.
• Communicate/interface with NAV CANADA according to their "Best Practices" documents.
✓	✓	Flight service stations, flight information centres	
	✓	Communication procedures	
	✓	ATC clearances/instructions/mandatory read back procedures	
	✓	Aerodrome operations−controlled	
	✓	Aerodrome operations−uncontrolled	
	✓	Mandatory and aerodrome traffic frequencies	

Section 2: RPAS airframes, power plants, propulsion and systems

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives The small RPAS pilot operating within visual line of sight must be able to:
Basic	**Advanced**		
		Airframes	
✓	✓	1. Handling/care/securing	• Indicate how manufacturers identify the repairs and work that can be undertaken by the operator vs. what must be addressed by an authorized repair facility (e.g. how to find your applicable original equipment manufacturer guidelines). • Describe the importance of identifying propeller/rotor damage, surface contamination, wiring damage, structural damage. • Identify the parts of an airframe.
		Electrical systems	
✓	✓	1. Typical electrical system components (motors, electronic speed controllers, batteries, etc.)	• Describe typical electrical system components.
✓	✓	2. Servo motors	• Describe the actions of a servo.
✓	✓	3. Importance of component integrity/maintenance	• Describe the indications of a failed servo. • Explain the importance of keeping components dry.
		Redundancies & critical items	
✓	✓	1. Risks of flying with inoperative systems	• State the value of redundancy in operating scenarios.
		Ground control station	
✓	✓	1. Orientation	• State the importance of pilot and antenna

✓		✓	2. Software version control	orientations.
✓		✓	3. Flight simulation	
			Data links	
✓		✓	1. Frequency bands (licensed and unlicensed)	• Describe how to assess the RF environment or conduct and RF sweep.
✓		✓	2. Line-of-sight	• Discuss the importance of radio line-of-sight.
✓		✓	3. Antennae and tracking systems	• Discuss the importance of GCS antenna placement.
✓		✓	4. Interference	• Discuss the causes of lost link and methods of recovery.
✓		✓	5. Gain, signal to noise ratio	
			Batteries	
✓		✓	1. Types and hazards	• Interpret maintenance log history.
✓		✓	2. Battery parameters (Ah, voltage, charge and discharge rates ("C")	• Describe the variables affecting batteries (capacity e.g. due to age, history, charge status).
✓		✓	3. Battery configurations (parallel, series)	• Assess battery voltages (understand discharge curves).
✓		✓	4. Charge cycles, storage, and maintenance	
✓		✓	5. Discharge curves	
✓		✓	6. Transportation of batteries (Dangerous Goods Regulations)	• Describe the regulations applicable to taking lithium-ion batteries on board a commercial flight.
				• Describe the dangers of using water on lithium battery fires.
			Autopilots	
✓		✓	1. The role of an autopilot	• Describe the types of pilot intervention possible during flight.
✓		✓	2. Different levels of control (e.g. stabilization vs. waypoint)	
✓		✓	3. Flight termination systems (internal and remote)	• Describe the pre-flight preparation related to flight termination systems.
✓		✓	4. Software version control (ground control station and sRPAS)	• Discuss the possible consequences of

			improper software version control. • Describe the importance of updating verified firmware only from the OEM website.
		Payloads	
✓	✓	1. Sensor types (electro-optical, infra-red, radio refrequency, atmospheric, etc.)	• Define what comprises the payload vs. the rest of the system.
		Electric motors (propulsion)	
✓	✓	1. Types of motors (brush, brushless, inrunner, outrunner)	• Describe the characteristics of different motor types.
✓	✓	2. Speed controllers	
		Launch and recovery systems	
✓	✓	1. Types of launchers	• Identify the different danger areas of a safety template.
✓	✓	2. Types of recovery systems–parachute, deep stall, arresting system/hook, normal landing	• Describe different methods of recovering an unmanned aircraft.
✓	✓	3. Safety areas and templates for launch and recovery	
		Maintenance and record keeping	
✓	✓	1. Technical log requirements	• List the requirements for record-keeping. • Give examples of tasks that should be independently verified.
✓	✓	2. Servicing, elementary tasks, critical tasks	
✓	✓	3. 2-person perform/verify practice	
		Magnetic compass	
✓	✓	**1.** Principles of operation	• Explain the difference between magnetic and true north.
✓	✓	2. Variation	
✓	✓	3. Factors adversely affecting compass operation	• Explain what can affect compass operation and reliability.
✓	✓	4. Importance of calibration	

		Altimeter	
✓	✓	1. Principles of operation	• Explain the purpose of a barometric altimeter setting.
✓	✓	2. Errors and malfunctions	• Describe the effect of a blocked static system.
		Airspeed indicator	
✓	✓	1. Principles of operation	• Describe the difference between indicated and true airspeeds.
✓	✓	2. Errors and malfunctions	• Describe the effect of a blocked pitot system.
		Inertial measurement unit (IMU)	
✓	✓	1. Components	• Describe what the IMU responsible for.
✓	✓	2. Errors & malfunctions	• Give examples of what can cause the IMU to misbehave.

Section 3: Human factors

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives
Basic	**Advanced**		The small RPAS pilot operating within visual line of sight must be able to:
		Aviation physiology	
✓	✓	1. Vision/visual scanning techniques	• Describe good scanning techniques (visual, audio) for visual observers (conflicting aircraft).
✓	✓	2. Hearing	• Describe "perspective illusion" when looking at distant aircraft.
✓	✓	3. Orientation/disorientation (including visual/perspective/parallax illusions)	• Describe factors that affect alertness.
✓	✓	4. Body rhythms/jet lag	
✓	✓	5. Sleep/fatigue	
✓	✓	6. Anaesthetics	
		The pilot and the operating environment	
✓	✓	1. Medications (prescribed and over-the-counter)	• Describe the effects of a hangover on pilot performance.
✓	✓	2. Substance abuse (alcohol/drugs)	• Describe the effects of exposure to cold and excessive heat on pilot performance.
✓	✓	3. Heat/cold	• Describe the symptoms of carbon monoxide poisoning.
✓	✓	4. Noise	
✓	✓	5. Toxic hazards (including carbon monoxide–GCS vehicle)	
		Aviation psychology	
✓	✓	1. Factors that influence decision-making	• List factors that interfere with effective decision-making.
✓	✓	2. Situational awareness	• List the factors that affect situational awareness.
✓	✓	3. Stress	• Describe how a given operational risk might be managed.
✓	✓	4. Managing risk	
✓	✓	5. Attitudes	
✓	✓	6. Workload–attention and information processing	
		Pilot–equipment/materials relationship	

✓	✓	1. Controls and displays−errors in interpretation and control	• Explain the benefits of standard operating procedures and lessons learned.
✓	✓	2. Standard operating procedures−rationale/benefits	• Explain how to manage an interruption to a checklist.
✓	✓	3. Correct use of check-lists and manuals	
✓	✓	4. Automation and complacency	
		Interpersonal relations	
✓	✓	1. Communications with flight crew/air traffic services/customers/public/authorities	• Resolve differences peacefully. • Promote open communications.
✓	✓	2. Operating pressures−family relationships/peer group	• Place safety requirements over hierarchy/position in organization/politics.
✓	✓	3. Operating pressures−employer	

Section 4: Meteorology

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives The small RPAS pilot operating within visual line of sight must be able to:
Basic	Advanced		
		The earth's atmosphere	
	✓	1. Composition and physical properties	• Describe the chemical composition of the atmosphere.
✓	✓	2. Density and pressure	
		Atmospheric pressure	
	✓	1. Pressure measurements	• Define atmospheric pressure, station pressure, sea level pressure.
	✓	2. Station pressure	• Explain how atmospheric pressure varies with height.
	✓	3. Sea level pressure	
	✓	4. Pressure system and their variations	• Explain the movement of air resulting from high and low pressure systems, convergence, and divergence.
	✓	5. Effects of temperature	• Relate weather characteristics to pressure systems.
		Meteorological aspects of altimetry	
	✓	1. Pressure altitude	• Recall the factors that affect density altitude.
	✓	2. Density altitude	• Assess weather and density altitude for anticipated performance (take-off and launch) and flight envelope limitations.
	✓	3. Altimeter settings	
		Moisture	
	✓	1. Temperature variations with altitude	• Explain the relationship between lapse rate, temperature-dewpoint spread and cloud base.
	✓	2. Relative humidity/dewpoint	• Explain the effect of moisture and temperature on the formation of clouds, height of cloud base.
	✓	3. Cloud formation	
	✓	4. Precipitation	• Discuss the significance of cloud base height on potential air traffic.

		Stability and instability	
	✓	1. Characteristics of stable/unstable air	• Characterize the effects of stable and unstable air masses (visibility, turbulence, smog layers).
	✓	2. Surface heating/cooling	
	✓	3. Lifting processes	
		Clouds	
✓	✓	1. Types applicable to low level flying and Recognition	• Identify cloud types and their impact on flying operations.
✓	✓	2. Associated precipitation and turbulence	• Discuss the significance of observed vertical cloud development.
		Surface based layers	
✓	✓	1. Fog formation	• Explain how fog is formed.
✓	✓	2. Haze/smoke	• Identify the elements that can dissipate fog.
✓	✓	3. Blowing obstruction to vision	
		Turbulence	
✓	✓	1. Convection	• Explain the sources of mechanical turbulence.
✓	✓	2. Mechanical	• Describe the formation of turbulence around large objects and mountain tops.
✓	✓	3. Orographic	• Identify sources of micro-climate turbulence and wind shear.
✓	✓	4. Wind shear	
		Wind	
✓	✓	1. Pressure gradient	• Explain the effect of pressure gradient on the horizontal movement of air.
✓	✓	2. Low level winds–variation in surface wind	• Explain how wind changes in the friction layer due to surface heating.
✓	✓	3. Friction	• Define wind shear and its effect on turbulence.
✓	✓	4. Diurnal effects	• Explain the formation of land/sea breezes.
✓	✓	5. Land/sea breezes	• Use a picture to explain anabatic and katabatic
✓	✓	6. Katabatic/anabatic effects	
✓	✓	7. Topographical effects	

			winds.
		Fronts and frontal weather	
	✓	1. Structure/frontal wave	• Discuss the relationship between air masses and creation of weather fronts.
	✓	2. Cold front	
	✓	3. Warm front	• Describe the changes in weather as a front approaches and passes over your location.
		Aircraft icing	
✓	✓	1. Formation	• Explain how icing is formed and the conditions that cause it.
✓	✓	2. In-flight–freezing rain	
✓	✓	3. Hoar frost	• Recognize weather conditions that can cause surface contamination.
✓	✓	4. Effect of frost and ice on launch and recovery systems	• Describe the components of a RPAS that are susceptible to icing.
		Thunderstorms	
	✓	1. Requirements for development	• Describe the three stages of thunderstorm development.
	✓	2. Types–air mass/frontal	
	✓	3. Hazards–updrafts/downdrafts/gust fronts/downbursts/microbursts/hail/lightning/antennas	• Describe the surface weather characteristics of an approaching thunderstorm.
	✓	4. Squall lines	• Identify hazards likely to occur with thunderstorm activity.
		Meteorological services available to pilots	
	✓	1. Flight Information Centres (FIC)–telephone service	• Identify the sources for local weather information.
✓	✓	2. Aviation weather web site	• Describe the differences in cloud base and wind forecasts between aviation and non-aviation sources.
	✓	3. Automatic Terminal Information Service (ATIS)	
✓	✓	4. Non-aviation sources	
		Aviation weather reports	

	✓	1. Aviation Routine Weather Report (METAR), Automated Weather Observation Station (AWOS), Basic Weather Information System (LWIS)	• Compare reported weather with the regulatory requirements. • Demonstrate awareness of coded weather information, and identify methods of decoding. • Identify sources of weather reports (websites etc.).	
		Aviation forecasts		
	✓	1. Times issued and validity periods	• Compare forecast weather with the regulatory requirements. • Assess forecast ceiling, wind, turbulence, precipitation and visibility against operational objectives. • Assess forecast vs. control station requirements (e.g. lightning).	
	✓	2. Aerodrome Forecasts (TAF)		

Section 5: Navigation

| Small RPAS type of operation | | Knowledge areas (topics) | Sample learning objectives |
Basic	Advanced		The small RPAS pilot operating within visual line of sight must be able to:
		Definitions	
✓	✓	1. Longitude	
✓	✓	2. Latitude	
	✓	3. Variation	
	✓	4. Track	
	✓	5. Heading	
	✓	6. Airspeed	
	✓	7. Bearing	
	✓	8. Wind velocity	
	✓	9. Drift	
		Maps and charts	
✓	✓	1. Aeronautical charts:VNC,VTA	• Locate your position on an aeronautical chart.
✓	✓	2. Topographical symbols	• Interpret topographical information from charts.
✓	✓	3. Elevation and contours (relief)	• Determine your distance from the nearest aerodrome.
✓	✓	4. Aeronautical information	• Identify a control zone on an aeronautical chart.
✓	✓	5. Scale and units of measurement	• Determine the validity/currency of aeronautical charts.
✓	✓	6. Locating position by latitude and longitude	• Use the CFS or other approved publication to identify airport operators and air traffic control agencies.
✓	✓	7. Canada Flight Supplement (CFS)	
		Time and longitude	
✓	✓	1. 24 Hour system	• Convert UTC to local time & vice versa.
✓	✓	2. Conversion of Universal Coordinated Time (UTC) to local and vice versa	• Determine local time of sunrise/sunset.

✓	✓	3. Sunrise and sunset	
		Pilot navigation	
✓	✓	1. Use of aeronautical charts	• Describe location and activities referring to appropriate aeronautical charts and aeronautical reference points.
	✓	2. Measurement of bearing and distance	
	✓	3. Variation	
	✓	4. True track/magnetic track	• Identify the class of airspace and proximity of aerodromes to the operating location using aeronautical charts.
	✓	5. True/magnetic/headings	
	✓	6. Airspeed vs groundspeed	• Explain the difference between true and magnetic heading.
		Flight planning	
✓	✓	1. Factors affecting choice of flying area	• Describe the factors that will influence your choice of flying area (restricted airspace, property lines, requirement for an SFOC, etc.).
✓	✓	2. NOTAM	
✓	✓	3. Use of Canada Flight Supplement (CFS)	• State where to obtain NOTAMs.
✓	✓	4. Fuel/energy requirements	• Obtain NOTAMs, and interpret them.
✓	✓	5. Weight and balance	• Demonstrate how to use the CFS to determine type and radius of airspace, frequencies, aerodrome operator contact information, nearest FIC/ATS unit for emergency contact, etc.
✓	✓	6. Documents to be available at ground control station	
✓	✓	7. Aircraft serviceability, configuration	
✓	✓	8. Effect of wind on range and endurance	• Determine the contact information for Emergency Services and local authorities.
			• List the documents that must be available at the ground control station.

			• Determine the serviceability of
			  o Aircraft
			  o Control station
			  o Radio frequency (RF) equipment
			  o Launch and recovery equipment

			o Software loads and versions o Correct databases (e.g. maps) loaded o Batteries (capacity (i.e. due to age) history, charge status, demand due to weight) • Demonstrate how to verify the flight plan data file is correct and complete in the autopilot.
		Radio theory	
✓	✓	1. Characteristics of low/high and very & ultra-high frequency radio waves	• Explain the characteristics of radio wave propagation.
✓	✓	2. Frequency bands used in navigation and communication	• Describe the factors that affect radio reception range.
✓	✓	3. Operational limitations, propagation, causes of interference	• Identify sources of RF interference. • Describe how to assess an RF environment. • Explain the function of RF spectrum analyzer.
		Global navigation satellite system (GNSS/GPS)	
	✓	1. Principles of operation	• Describe how GNSS systems may be enhanced by augmentation systems.
	✓	2. Causes of signal loss and interference	• Provide an example of how Differential Global Positioning Service (DGPS) might be used for landing. • Discuss the significance of GPS loss in flight. • Describe what can affect GPS performance (number of satellites, weather).
		Other radio and radar aids–basic principles and use	
	✓	1. Air traffic control (ATC) transponder	• Describe the function of an ATC radar transponder.
	✓	2. Locator devices	

Section 6: Flight operations

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives The small RPAS pilot operating within visual line of sight must be able to:
Basic	**Advanced**		
		General	
✓	✓	1. Pilot-in-command responsibilities	• Describe the hazards that can occur in different geographic or topographical areas.
✓	✓	2. Aircraft defects	• Describe the normal flow of manned aircraft traffic at an aerodrome (circuit, taxiing, etc.).
✓	✓	3. Winter operations	
✓	✓	4. Thunderstorm avoidance	• Explain how local and portable devices might be controlled to reduce interference.
✓	✓	5. Wildlife hazards	
✓	✓	6. Wildlife conservation	
✓	✓	7. Collision avoidance−use of lights	
	✓	8. Runway numbering	
	✓	9. Aerodrome operations (Procedures for the prevention of runway incursions and conflicts)	
✓	✓	10. Radio/electronic interference, portable electronic devices	
		Aircraft performance	
✓	✓	1. Effects of density altitude and humidity	• Describe the effect of density altitude on launch and climb performance.
✓	✓	2. Bank/speed vs rate/radius of turn	• Describe the effect of airspeed on radius of turn.
✓	✓	3. Use of aircraft flight manual	• Determine operating limitations from the aircraft flight manual.
		Performance charts/data	
✓	✓	1. Factors affecting launcher performance (e.g. ice, temperature)	• Describe the effect of temperature on elasticized cord launchers, pneumatic launchers or hydraulic launchers.
✓	✓	2. Cross-wind limits	• Identify cross-wind limits.
✓	✓	3. Factors affecting performance (battery, wind, speeds, climb power, etc.)	

✓	✓	4. Hover ceiling, maximum altitude	• Using aircraft performance data, determine the maximum altitude at which the rotorcraft can hover.
		Weight and balance	
✓	✓	1. Locating centre of gravity (C of G)	• Describe methods of determining C of G.
✓	✓	2. Weights–e.g. empty/gross	• Describe how to return a C of G to within limits.
✓	✓	3. External loads–effect on performance and stability	
		Aircraft critical surface contamination	
✓	✓	1. Effects of aircraft critical surface contamination on performance	• Describe the effects of surface contamination on airfoils.
✓	✓	2. Types of contaminants (e.g. water, frost, snow, condensation, tape, etc.)	
		RPAS operations (VLOS)	
✓	✓	1. Land owner authorizations	• Identify typical functional areas in a VLOS site (e.g. launch, observer).
✓	✓	2. Coordination with public safety (municipality)	• Identify desirable characteristics of alternate recovery areas.
✓	✓	3. Charging areas	
✓	✓	4. Site control, safety perimeter	• Identify the requirements of visual observer locations.
✓	✓	5. Launch points, recovery points	• Identify and evaluate access routes for both normal and emergency operations.
✓	✓	6. Obstacles	
✓	✓	7. Emergency procedures	• Assess public access and determine crowd control requirements.
✓	✓	8. Defining roles and responsibilities	
✓	✓	9. Communications	• List typical emergency contacts appropriate to flying site (flyaways, EMS etc.).
✓	✓	10. Post flight actions (download data, safety actions, etc.)	• List the safety equipment necessary for the operation (fire extinguisher, first aid, etc.).
			• List the typical items in a crew briefing.
			• Describe emergency procedures (e.g. airspace

			conflicts, system faults, lost link, public interference).
			• List the typical items in a crew briefing. (roles, objective & plan, timeline, performance limitations, emergency procedures, airspace conflicts and escape manoeuvres, flyaways, public interference, recovery area, interface with the client and public, site manager, safe areas, expectations of what they will observe, electro-magnetic interference, "clean cockpit" (no interference of distractions)).
			• Communicate vital actions (countdown and launch command, emergency abort, transfer of control, air traffic contacts, progress and expected manoeuvres).
			• List recommended post-flight actions (download data, check for damage, clean and dry as needed, remove batteries, record information into logs, disassemble and pack per system manual, etc.).
		Occupational safety & health	
✓	✓	1. Charging areas	• List the safety equipment necessary for the operation (fire extinguishers, first aid kit, etc.).
✓	✓	2. Launch points, recovery points	
✓	✓	3. Obstacles	• Assess weather threats vs ground station operations.
✓	✓	4. Emergency procedures	
✓	✓	5. Responsibilities	• Identify and evaluate access routes.
✓	✓	6. Communications	• Assess public access and determine crowd control requirements.
✓	✓	7. Post-flight actions	• List typical emergency contacts appropriate to flying site (flyaways, EMS etc.)
			• Identify legal site access issues (trespass, insurance, permissions, safety training).

			• List typical personal safety equipment. • Describe the hazards of launchers and recovery systems.

Section 7: Theory of flight

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives
Basic	Advanced		The small RPAS pilot operating within visual line of sight must be able to:
		Principles of flight	
✓	✓	1. Bernoulli's principle	• Describe how lift is produced.
✓	✓	2. Newton's laws	
		Aircraft parts and components	
✓	✓	1. Fixed wing	• Explain the function of the vertical fin.
✓	✓	2. Multi-rotor aircraft	• Identify basic components including lifting and
✓	✓	3. Helicopter components	stabilizing components.
		Forces acting on an aircraft	
✓	✓	1. Lift	• Identify the 4 forces acting on an aircraft in flight.
✓	✓	2. Drag–induced/parasite	• Describe how the 4 forces are balanced during
✓	✓	3. Thrust	manoeuvres and steady flight.
✓	✓	4. Weight	
✓	✓	5. Equilibrium	
		Stability	
✓	✓	1. Longitudinal, lateral, directional stability	• Explain how the centre of gravity affects longitudinal
✓	✓	2. Inherent stability	stability.
✓	✓	3. Methods of achieving stability, effect of C of G position	
		Aerofoils	
✓	✓	1. Relative airflow and angle of attack	• Explain how lift is controlled.
✓	✓	2. Relationship of lift and drag to angle of attack	
✓	✓	3. Aerodynamic stall	

		Propellers & rotors	
✓	✓	1. Handling and care	• Describe how the condition of the prop/rotor affects performance.
		Design of the wing	
✓	✓	1. Wing planform	• Describe how the design of the wing affects performance.
✓	✓	2. Spoilers	
✓	✓	3. Flaps	
		Aeroplane flight controls	
✓	✓	1. Aeroplane axes and planes of movement	• Describe the function of different control surfaces.
✓	✓	2. Control surfaces	• Explain the function of trim.
✓	✓	3. Trim	
		Helicopter flight controls	
✓	✓	1. Cyclic	• Describe how lift is created with a rotary wing (powered and autorotation).
✓	✓	2. Collective	• Describe how lift is controlled.
✓	✓	3. Tail rotor	• Describe the function of the tail rotor, counter-rotating rotors.
		Multi-rotor aircraft dynamics	
✓	✓	1. Principles of flight and torque	• Describe how yaw, pitch, roll and climb are achieved in a multi-rotor aircraft.
✓	✓	2. Pilot flight controls	• Describe how to avoid dynamic rollover in a cross-wind.
✓	✓	3. Settling with power	• Describe typical multi-rotor autopilot modes (manual, attitude, GPS Position hold).
✓	✓	4. Recirculation	• Describe how asymmetric recirculation can upset lateral control of a rotorcraft.
✓	✓	5. Dynamic rollover	

		Load factor	
✓	✓	1. Load factor−turns	• Describe what can affect the load factor on an aircraft.
✓	✓	2. Gust loads, turbulence	• Recall that increasing the load factor produces a requirement for increased lift, thus producing increased drag.
✓	✓	3. Structural/power limitations	

Section 8: Radiotelephony

| Small RPAS type of operation | | Knowledge areas (topics) | Sample learning objectives |
Basic	Advanced		The small RPAS pilot operating within visual line of sight must be able to:
		Communications	
	✔	1. Operator's certificate (aeronautical) - (Industry Canada Operator Certificate – with Aeronautical Qualification course)	• Interpret aeronautical radio communications (position, phase of flight). • Communicate using standard radio terminology.
	✔	2. Terminology	• Give an example of a routine blind broadcast.
	✔	3. Common frequencies	• List the contents of a routine call to ATC.
	✔	4. Emergencies	• Give an example of an emergency (flyaway) broadcast. • Distinguish between "height" and "altitude" in communications. • Give examples of proper radio etiquette, including practices to avoid interfering with other communications.
		Ground crewmember radios	
✔	✔	1. Terminology	• Give an example of an advisory describing a possible aircraft conflict.
✔	✔	2. Reception performance	• Describe factors affecting radio reception range. • Describe the verbal communication elements in a positive transfer of control or visual following.

Appendix A: Flight reviewer's guide - sRPAS exercises

Small RPAS type of operation		Knowledge areas (topics)	Sample learning objectives The small RPA pilot operating within visual line of sight must be able to:
Basic	Advanced		
		Pre-flight planning procedures	
	✓	1. Plan a flight of at least 15 minutes duration simulating a normal operational sRPAS flight which shall, at a minimum, include one (1) take-off and one (1) full stop landing.	• Provide a satisfactory site survey; • Brief flight crew or visual observers of any duties they are to perform or any other information relevant to the flight; • Use appropriate and current aeronautical charts and other current flight publications; • Properly identify airspace, obstructions, and terrain features; • Select a safe and efficient take-off location and flight route; • Obtain all pertinent information about local air routes and aerodromes; • Retrieve and interpret weather information and NOTAM relevant to the intended flight; • Determine the acceptability of existing or forecast weather conditions; • Select the most favourable and appropriate altitudes, considering weather conditions and equipment limitations; • Determine the appropriate departure procedure; • Make a competent "GO/NO-GO" decision based on available information for the flight; • Demonstrate that the weights and center of gravity are within acceptable manufactures limits; • Determine the impact on their sRPAS operations, of

			unserviceability of equipment or equipment configuration changes for the proposed flight; and • Organize and arrange material and equipment in a manner that makes the items readily available.
		Emergency procedures	
	✓	1. Demonstrate the procedures to be used when an emergency occurs.	• Describe emergency procedures that apply to your sRPAS; • Describe the lost-link procedures that apply to your sRPAS; • Describe the procedures to follow in the event of a fly-away, including who to contact.
	✓	**Perform a take-off**	
		1. Perform an organized and efficient safe departure	• Complete all pre-flight inspection/checks on your sRPAS; • Note take-off time; • Use an organized and efficient procedure to take off; • Comply with all departure clearances and instructions if the flight review is conducted in controlled airspace; and • Complete appropriate checklists.
		Manual flight procedure	
	✓	1. Show the ability to manually control the sRPAS through various stages of flight.	• Maintain a stable airspeed, cruising altitude, and heading; • Navigate by applying systematic navigation techniques; • Orient the sRPAS to the direction of flight;

			• Navigate around an obstacle or fixed point;
			• Determine the position of the aircraft with respect to distance and altitude from the candidate;
			• Apply an organized method that would:
			    ○ verify the position of the aircraft
			    ○ revise headings to correct any existing track error to maintain the aircraft's position due to wind
			    ○ confirm or revise the battery power available at the destination landing point with a degree of accuracy that would make arrival assured
			    ○ confirm current fuel/power levels vs requirements for the flight

		Lost link procedures	
	✔	1. Demonstrate verbally the procedures to be used when a lost link occurs.	• Correctly program the sRPAS for a "return to home" if it is equipped with that function; • Select a power setting and altitude appropriate for the lost link situation; • Promptly recognize when a lost link has occurred; • Show an ability to regain control of the sRPAS if it reconnects the lost link; • Take an appropriate course of action, once link has been re-established and confirmed; and • Contact the appropriate facility to provide information on the lost link if needed.
		"Fly away" procedures	
	✔	1. Verbally demonstrate the ability to perform all the needed actions relating to a "fly away" situation.	• Perform the following tasks without undue delay: ○ Identify and record their present position

			- Identify and record the direction and altitude the sRPAS was last seen travelling - Estimate the approximate available flight time that will remain with the fuel/power on board upon arrival at the destination (Example: 15 minutes) - Without delay contact the appropriate facility to provide information on the "fly away" if needed.
		Perform a landing	
	✓	1. Perform an organized and efficient safe arrival.	- Use an organized and efficient procedure to land; - Comply with all arrival clearances and instructions if the flight review is conducted in controlled airspace; - Complete appropriate checklists; - Note landing time; - Secure the sRPAS.

Enquiries

Information concerning the operation of small RPASs and pilot certification may be obtained by contacting the appropriate Transport Canada Regional Offices. A complete listing may be found at: http://www.tc.gc.ca/eng/civilaviation/opssvs/regions-139.htm.

Recommended study material

Transport Canada publications (TP), including the following, may be purchased from retailers, or at the following web site: http://www.tc.gc.ca/eng/civilaviation/publications/menu.htm
- Human Factors for Aviation - Basic Handbook (TP 12863), and Advanced Handbook (TP 12864)
  - Transport Canada Aeronautical Information Manual (TC AIM) (TP14371)
    http://www.tc.gc.ca/eng/civilaviation/publications/tp14371-menu-3092.htm

The Study Guide for the Radiotelephone Restricted Operator Certificate - Aeronautical (RIC-21) is available free of charge from district offices of Industry Canada - Examinations and Radio Licensing (http://www.strategis.gc.ca).

Canadian Aviation Regulations (CARs) are available online at:
http://laws-lois.justice.gc.ca/eng/regulations/SOR-96-433/index.html

NAV CANADA publications, including the following, may be purchased from retailers, or at the following web site:
http://www.navcanada.ca/EN/products-and-services/Pages/aeronautical-information-products.aspx
- VFR Navigation Charts (VNC)/VFR Terminal Area Charts (VTA)
- Canada Flight Supplement
The NAV CANADA VFR Phraseology guide is available for download at
https://www.navcanada.ca/EN/media/Publications/VFR%20Phraseology.pdf

Some NAV CANADA regions have developed Best Practices for dealing with RPAS. Those documents are available for download at
https://flitelab.files.wordpress.com/2015/08/vr-fir-uav-best-practices-vruav-2015-final.pdf
A copy of the Vancouver Flight Information Region UAV Best Practices can be requested by e-mail from uav_vr@navcanada.ca

Information on the Transportation of Dangerous Goods is available from Transport Canada.
http://www.tc.gc.ca/eng/tdg/safety-menu.htm

Text books and other publications produced by commercial publishers can be obtained through local flying training organization, bookstores and similar sources.